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Engineering Library

## The Engineer

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PUBLIC NOTICES

ASSISTANT LOCOMOTIVE SUPERINTENDENTS, INDIAN STATE RAILWAYS.

The Secretary of State for India will, in 1921, with the advice of a Selection Committee, make THREE APPOINTMENTS of ASSISTANT LOCOMOTIVE SUPERINTENDENTS for service on Indian State Railways, if so many suitable candidates present themselves.

Candidates must be British subjects, not more than 27 years of age, and must be of good moral character and sound physique. They must have had a good general and technical education, followed by at least three years' training in the locomotive workshops of a British Railway Company, or a locomotive builder of repute, and should have had six months' training in the running sheds and firing. A knowledge of applied mechanics and the nature and composition of all materials used in shops is essential, and applicants should be able to design and to calculate the stresses on the parts of the machines. Some drawing-office experience is also desirable.

Persons whose practical experience falls short of three years, but who have served in His Majesty's Forces during the war, will be eligible as candidates; but, if selected, will be required before appointment to complete satisfactorily such further period of training as the Secretary of State may prescribe.

Candidates may be required to appear before a Selection Committee at the India Office. They will also be required to pass a medical examination if selected for appointment.

The regulations in respect of the appointments and forms of application for use by candidates can be obtained on application to the SECRETARY, Public Works Department, India Office, Whitehall, London, S.W.1. Applications for appointment must reach the India Office not later than 15th November, 1921.

India Office,
22nd September, 1921. 6252

City of Cardiff Education Committee.

THE TECHNICAL COLLEGE.

PRINCIPAL: CHARLES COLES, B.Sc. (Lond.)

DEPARTMENT OF ENGINEERING.

HEAD OF DEPARTMENT: A. W. LOVERIDGE, B.Sc. (Eng.), A.R.C.Sc.

The following courses have been arranged for Engineering Students:—

A Three Years' Course in Mechanical and Marine Engineering, jointly with the University College of South Wales and Monmouthshire.

A Two Years' Course for Apprentices and others with facilities for practical experience in the summer term.

These courses are suitable for students preparing for degrees in engineering or for the examinations of the Engineering Societies.

Special Courses are also arranged for Marine Engineers preparing for the examinations of the Board of Trade.

Further information in regard to full-time and part-time Courses, fees, &c., may be obtained on application to the Principal.

JOHN J. JACKSON, B.A.,
Director of Education.
City Hall, Cardiff. 6159

ENGINEERING AND TECHNICAL OPTICS.

Northampton Polytechnic Institute,
ST. JOHN-STREET, LONDON, E.C. 1.

ENGINEERING DAY COLLEGE.

Full-time Courses in the Theory and Practice of Civil, Mechanical, and Electrical Engineering. The Courses in Civil and Mechanical Engineering include specialisation in Automobile and AERONAUTICAL Engineering, and those in Electrical Engineering include specialisation in RADIO-TELEGRAPHY.

A SPECIAL ENTRANCE EXAMINATION is held at the end of September before the commencement of each session. The Courses include periods spent in commercial workshops and extend over four years. They also prepare for the Degree of B.Sc. in Engineering at the University of London. Fees £18 or £13 per annum.

THREE ENTRANCE SCHOLARSHIPS of the value of £62 each for the complete course will be offered for competition at the annual entrance examination in September.

OPTICAL ENGINEERING AND TECHNICAL OPTICS.

Full and Part-time Courses in this important Department of Applied Science are given in specially equipped laboratories and lecture rooms. The annual Entrance Examination is held at the end of September.

EVENING TECHNICAL COURSES

in all branches of Mechanical and Electrical Engineering commence on Monday, September 26th, 1921.

The laboratories, both mechanical and electrical, are well equipped with modern apparatus which, on the mechanical side, provides for specialisation in Automobile and Aeronautical Engineering, and, on the electrical side, for specialisation in Alternate and Continuous-current Work, in Radio-telegraphy and Telephony, and in Electrical Testing.

Particulars as to fees, dates, &c., and all information respecting the work of the Institute can be obtained at the Institute or on application to

R. MULLINEUX WALMSLEY, D.Sc.,
Principal.
6138

Artillery College, Woolwich.

DEPARTMENT OF MECHANICAL AND ELECTRICAL ENGINEERING.

PROFESSOR: Mr. J. J. GUEST.

APPLICATIONS are INVITED for the POSTS of:—

JUNIOR LECTURER. Salary £400 p.a. to £500 p.a.;

DEMONSTRATOR. Salary £300 p.a. to £400 p.a.; in the Mechanical Engineering Section.

Posts pensionable under the Federated Superannuation Scheme for Universities.

The Junior Lecturer preferably should have had experience in Internal Combustion Engine Work.

Applications should be made in writing to—

THE COMMANDANT,
Artillery College,
Red Barracks,
Woolwich, S.E. 18,
from whom further particulars may be obtained.
6275

PUBLIC NOTICES

APPOINTMENTS BOARD OF THE Imperial College of Science and TECHNOLOGY,
SOUTH KENSINGTON, S.W. 7.

EMPLOYERS REQUIRING MEN who have received a thorough training in Science and Technology and who are Diplomates or Associates of the Imperial College or of one of its three constituent Colleges, are asked to MAKE USE of the SERVICES of the BOARD. No fees.

The Imperial College includes the Royal College of Science, the Royal College of Mines, and the City and Guilds (Engineering) College. The Associates of the Colleges receive thorough training in Science and Technology, including Aeronautics, Applied Optics and Optical Engineering, Biology, Chemical Technology, Chemistry (all branches), Engineering (all branches, including Metallurgy, Mining, Mining Geology, and Oil Technology), Geology, Mathematics and Mechanics, and Physics. 6253

PATENTS AND DESIGNS ACTS, 1907 AND 1919.
MACHINE FOR MAKING BOXES.

The Proprietors of British Letters PATENT No. 13,246/15 are PREPARED to SELL the PATENT or to LICENSE British Manufacturers to work under it. It relates to a machine for making boxes of paper and thin wood.

Address: BOULT, WADE and TENNANT, 111/112, Hatton-garden, London, E.C. 1.
6246

PATENTS AND DESIGNS ACTS, 1907 AND 1919.
WIRE STITCHING OR STAPLING MACHINE.

The Proprietors of British Letters PATENT No. 112,910 are PREPARED to SELL the PATENT or to LICENSE British Manufacturers to work thereunder. It comprises an improved differential motion device for operating the bender bar and the mechanism for driving the staples through the work and clinching their legs.

Address: BOULT, WADE and TENNANT, 111 and 112, Hatton-garden, London, E.C. 1.
6247

PATENTS AND DESIGNS ACTS, 1907 AND 1919.
TROLLEY ARMS.

The Proprietor of British Letters PATENT No. 25,577 of 1912 is PREPARED to SELL the PATENT or to LICENSE British Manufacturers to work under it.

It relates to means for supporting a trolley arm when it is uncoupled automatically, limiting its downward movement during the re-engaging operation and ensuring its positive lifting movement.

Address: BOULT, WADE and TENNANT, 111/112, Hatton-garden, London, E.C. 1.
6264

The Proprietor of Patent No. 22,493 of 1912, for "IMPROVEMENTS IN BOILER TUBE CLEANER SYSTEMS," is DESIROUS of DISPOSING of the PATENT RIGHTS or of NEGOTIATING for the GRANT of LICENCES to work thereunder.

Communications should be addressed to—
F. W. GOLBY, Patent Agent,
Late of His Majesty's Patent Office,
3, John-street, Bedford-row, London, W.C. 1.
6206

PUBLIC NOTICES

Portsmouth Municipal College.

MECHANICAL AND CIVIL ENGINEERING DEPARTMENT.

PRINCIPAL: OLIVER FREEMAN, Wh.Sc., A.R.C.S., B.Sc.

HEAD OF DEPARTMENT: E. C. PRESCOTT, M.Sc. (Tech.), A.M.S.T.

APPLICATIONS are INVITED for the APPOINTMENT of a LECTURER in MECHANICAL ENGINEERING. Salary according to the Burnham Committee's Scale. Further particulars and forms of application may be obtained from the undersigned, to whom applications should be returned at once, accompanied by copies only of not more than three recent testimonials.

H. E. CURTIS,
Secretary.
Offices for Higher Education,
The Municipal College, Portsmouth. 6292

Corporation of Aberdeen.

TENDERS FOR TRAMWAY MATERIAL.

The above Corporation invites TENDERS for the SUPPLY of the undermentioned TRAMWAY MATERIAL, all delivered F.O.R. at ABERDEEN:—

| | |
|---|---|
| RAILS— | |
| B.S.S. No. 4 | 600 Tons |
| B.S.S. No. 40 | 10 Tons |
| FISH-PLATES | 850 Pairs |
| FISH-PLATE BOLTS and NUTS | 4 Tons |
| TIE BARS | 19 Tons |
| ANCHOR BOLTS with Two Tapered Washers for each, 3in. grip, 1in. diam. | 10 Tons |
| CHILLED BLOCKS (12 lb. each, 3½in. by 4in. by 6in. deep, with 4in. centre rib) | 250 Tons |
| DRAIN BOXES | No. 44 |

All the above must be in accordance with the British Standard Specification for the various materials mentioned.

An alternative Tender is also requested for one-half of the quantities above-mentioned.

Sealed Tenders, stating guaranteed time of delivery and addressed to Mr. JOHN GORDON, Burgh Surveyor, Town House, Aberdeen, endorsed "Tenders for Tramway Material," must be lodged not later than Thursday, 6th October, 1921, at 10 a.m.

Burgh Surveyor's Office,
Town House, Aberdeen,
26th September, 1921. 6263

Newton Abbot Rural District Council.

LUSTLEIGH WATER SUPPLY.

TENDERS are INVITED for SUPPLYING, DELIVERING, and LAYING about 1400 YARDS of 3in. CAST IRON WATER MAINS, CONSTRUCTION of a RESERVOIR to contain about 11,000 gallons of water, together with the necessary SLUICE VALVES, HYDRANTS, CATTLE TROUGHS, and other FITTINGS and WORKS in connection with the above undertaking, all in the parish of Lustleigh.

Persons desirous of tendering should send in their names to Mr. S. Segar, the Engineer, 37, Devon-square, Newton Abbot.

Drawings may be seen and copies of specifications, bills of quantities and forms of Tender obtained at the office of Mr. Saml. Segar on payment of the sum of £2 2s., which will be returned upon receipt of a bona fide Tender.

Sealed Tenders, endorsed "Lustleigh Water Supply," to be delivered to me not later than Tuesday, the 11th October, 1921.

The lowest or any Tender not necessarily accepted.

By Order,
F. HORNER,
Clerk to the Council.
Council Offices,
64, East-street, Newton Abbot,
22nd September, 1921. 6255

PUBLIC NOTICES

Bombay, Baroda, and Central India Railway Company.

The Directors are prepared to receive up to Noon on Wednesday, 19th October, TENDERS for the SUPPLY of—

1. RED AND WHITE LEAD.
2. CANVAS, BUNTING, &c.
3. DISINFECTANT FLUID.
4. LAMPS, LAMP FITTINGS, and MISCELLANEOUS GLASS.
5. PAINTS, &c.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment as follows:—

For Nos. 1 and 2, 20s. each; for Nos. 3 and 4, 10s. each; and for No. 5, 5s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.
Offices: The White Mansion,
91, Petty France, Westminster, S.W. 1.
26/9/21. 6271

Madras and Southern Mahratta Railway Company, Limited.

The Directors are prepared to receive TENDERS for:
(1) 706 STEEL TYRES FOR ENGINES.
(2) 3020 HELICAL AND VOLUTE SPRINGS.
(3) 270 STEEL AXLES FOR LOCOMOTIVES.
(4) 800 LAMINATED SPRINGS.
(5) 1700 BRASS BOILER TUBES.
(6) 400 TYRES FOR CARRIAGES AND WAGONS,

in accordance with the specifications which may be seen at the offices of the Company. The charge for each specification is One Guinea, which will not be returned.

Tenders must be sent in, addressed to the SECRETARY, not later than 2 p.m. on Tuesday, the 18th October, 1921, marked "Tender for Tyres for Engines," or as the case may be.

The Directors do not bind themselves to accept the lowest or any Tender.

Company's Offices:
25, Buckingham Palace-road,
Westminster, S.W. 1.
28th September, 1921. 6280

Port of Bristol.

STEEL-BUILT OVERHEAD GALLERY FOR COLD STORES, ROYAL EDWARD DOCK, AVONMOUTH.

The Docks Committee are prepared to receive TENDERS for the CONSTRUCTION, &c., of an OVERHEAD GALLERY for use in connection with the Royal Edward Cold Stores, Avonmouth Dock.

On and after Tuesday, the 4th prox., copies of the specification and contract drawings can be obtained from the undersigned on production of a receipt showing that a deposit of £2 has been paid to the Bristol Docks Committee, 19, Queen-square, Bristol, to whom all cheques must be made payable. The deposit of £2 will be returned to bona fide tenderers after receipt of Tenders with all the prescribed documents and drawings.

Tenders must be enclosed in a sealed envelope, endorsed "Tender for Overhead Gallery," and addressed to the General Manager and Secretary of the Docks Committee, Dock Office, 19, Queen-square, Bristol, and must be delivered to him, accompanied by all the prescribed documents and drawings, before 10 a.m. on Tuesday, the 18th day of October, 1921.

The Docks Committee do not bind themselves to accept the lowest or any Tender.

THOMAS A. PEACE,
Engineer.
Engineer's Office, Avonmouth Dock,
27th September, 1921. 6266

Ministry of Finance, Egypt.

SURVEY OF EGYPT.—GIZA.

APPLICATIONS are INVITED for the POST of MECHANIC to the above Department, at a salary of £E432 per annum plus £E128 war bonus, which latter is liable to cancellation.

Applicants should have a thorough knowledge of the maintenance of a 60 H.P. Crude Oil Engine and Dynamo and be able to effect running repairs to Lithographic Printing Machinery. Preference will be given to applicants having a practical knowledge of electricity, particularly in respect to winding small direct-current motor armatures, as the printing machinery is electrically driven.

Candidates should not be more than 35 years of age.

The appointment will be on contract for a period of 2 years. The successful candidate, if recruited in Europe, will receive £E50 in lieu of passage expenses both to and from Egypt at the beginning and end of the period of service.

Information with respect to terms of service and contract with the Egyptian Government may be obtained from the Inspecting Engineer to the Egyptian and Sudanese Governments, Queen Anne's Chambers, Broadway, Westminster, London, S.W. 1.

Applications, together with copies of recent testimonials and statement of qualifications, should be addressed to the SURVEYOR-GENERAL, Survey of Egypt, Giza (Mudiriya), Egypt. 6268

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## SITUATIONS OPEN

EFFICIENCY ENGINEER, September 16th, 1921 (6151).—The numerous APPLICANTS for this POST are THANKED for their communications and are informed that so many applications have been received that some little time will necessarily elapse before a selection can be made for further communication. 6238 A

WANTED, a WORKING ENGINEER, to Take Charge of a Factory Plant in Leicestershire; must have had experience in the Upkeep of Steam Engines, Boilers, Electric Lighting Plant and General Machinery.—Write, stating age, wages, and particulars of previous employment, Box 1767, c/o Mather and Crawther, Ltd., 10/13, New Bridge-street, E.C. 4. 6186 A

WANTED, COMMERCIAL MAN with Engineering knowledge, to Deal with Inquiries and Orders for Structural and other similar Work in large Engineering Works in the Midlands. The position calls for an able correspondent capable of acting on his own initiative and controlling staff.—Address, stating age, qualifications, experience, and salary desired, 6235, The Engineer Office. 6235 A

WANTED, FOUNDRY MANAGER for Small Foundry in Midlands. Must be thoroughly experienced in high-class Engine Work, &c., Mixings, and be a good organiser. Excellent prospects. State experience, age, salary required, and when at liberty.—Address, 6290, The Engineer Office. 6290 A

WANTED, TRAVELLERS with Connections amongst Hardware Merchants and Engineering Sundries, to Push Sales of Bearing Metals.—Address, giving full particulars of district covered, 6272, The Engineer Office. 6272 A

A CAPABLE SELLING AGENT REQUIRED by a leading Firm of Lubricating Oil Manufacturers. Excellent opportunity for right man.—Write Box 212, Sell's Advertising Offices, Fleet-street, E.C. 4. 6171 A

A LARGE FIRM of MECHANICAL ENGINEERS in Yorkshire REQUIRE a smart COMMERCIAL REPRESENTATIVE, who will reside locally and occupy most of his time travelling throughout the British Isles, following up inquiries and securing fresh business. Only those with previous experience and good knowledge of engineering need apply. Replies treated confidentially.—Address 6249, The Engineer Office. 6249 A

ADVERTISERS REQUIRE TRAVELLERS Already covering Scotland, Ireland, South Wales, West of England, and South and East Coast to SELL Large Stocks of BLACK and BRIGHT BOLTS and NUTS at prices much below manufacturers' cost; good commission paid. Applicants must state ground covered, class of buyer, and what lines already offering.—Write, Box 75, c/o R. A. Knight and Co., Ltd., 1, Graham-buildings, London, E.C. 2. P4096 A

AGENT REQUIRED in Newcastle for North-East Coast district by old-established Firm of General Engineers and Centrifugal Pump Manufacturers. Previous experience in representation of first-class firm, combined with technical and commercial ability, essential.—Address, giving particulars of experience, 6262, The Engineer Office. 6262 A

GENERAL MANAGER WANTED for Large Engineering Works, chiefly concerned with the Manufacture of Engine Parts. Minimum salary £500 or according to qualifications and experience. State past experience, &c.—Address, P4108, The Engineer Office. P4108 A

MANAGER WANTED for Small Up-to-date Works Manufacturing Machine Tools, Greater London area.—Address, stating experience and salary required, 6265, The Engineer Office. 6265 A

POWER STATION ENGINEER REQUIRED for plant generating 2230 K.W. and 120,000 lb. steam. Experience of economical operation and maintenance of modern Boilers and Engines essential; Electrical Experience also desirable.
Give particulars of training, types of plant responsible for, age, and commencing salary.—Mark letters "Power" and address to "Engineer," CADBURY BROS., Ltd., Bournville. 6270 A

REQUIRED IMMEDIATELY for India, as ENGINEER SALESMAN, single man of good education and address, with railway experience.—Address, P4109, The Engineer Office. P4109 A

SECRETARY.—A Limited Company Making Textile Machinery, with registered office in Manchester, will REQUIRE the SERVICES of a competent MAN as SECRETARY and ACCOUNTANT; previous experience in a similar position and of cost systems essential.—Apply with full particulars and salary required to Box 16, Wheeler's Advertising Agency, Manchester. P4113 A

DRAUGHTSMAN (Mechanical Engineer) REQUIRED, Midlands; experienced in Design, Lay-out, Quantities and Estimating for Steam Engines and Waterworks Pumping Machinery. State full particulars of experience, age, and salary required.—Address, 6267, The Engineer Office. 6267 A

DRAUGHTSMAN.—First-class MAN REQUIRED for Detail Working Drawings, Steel-framed Buildings, Crane Girders, &c.—Apply, giving full particulars, age, salary, &c., SOUTH WALES STRUCTURAL CO., Swansea. 6250 A

DRAUGHTSMAN REQUIRED; Used to Concrete Mixing Machinery and Plant. State full experience and salary required.—Address, 6243, The Engineer Office. 6243 A

SENIOR DRAUGHTSMAN and ESTIMATOR REQUIRED. Full knowledge of Elevating, Screening, and Contractors' Plant. Must be capable of producing matured designs.—Address, stating age, full experience, and salary required, 6242, The Engineer Office. 6242 A

THREE SENIOR DRAUGHTSMEN REQUIRED, one each for Power Plant, Building and General Engineering Sections. Must have practical experience and good technical training. Apply by letter only, stating in tabular form details of education, firms worked for, and class of work, together with age, commencing salary required, &c.—Mark letter clearly "Draughtsman for ——— Section," and address, "Engineer," CADBURY BROTHERS, Ltd., Bournville. 6269 A

WANTED, Experienced FOREMAN, to Take Charge of Small Foundry near Calcutta. Must have good knowledge of Analyses and Mixing of Metals and thoroughly conversant with up-to-date Foundry Practice. Single man preferred; age not over 35.—Address, 6241, The Engineer Office. 6241 A

FOREMAN MILLWRIGHT REQUIRED for Large Works in Midlands. Good all-round experience with Engines, Boilers, Air Compressors, and General Repairs. Energetic and live man with first-class references. Age 35 to 40.—Address, giving salary required and copies of testimonials, 6183, The Engineer Office. 6183 A

FIRST-CLASS MECHANIC; Must Understand Steam Boilers, Motor Cars, and Electricity; able to do Fitting and Turning. Take Charge of Repairs and Overhaul Motor Cars.—Write full particulars, references, and wages required to B. C., 172, Great Portland-street, W. 6260 A

ACCOUNTANT WANTED, to go to France for the purpose of investigating accounts connected with contracts for the Purchase, Delivery, and Erection of Heavy Machinery for Steel Works.—Address, CHAS. G. BIGGS, Royal Metal Exchange, Swansea. P4100 A

## SITUATIONS OPEN (continued)

CLERK of WORKS WANTED. Practical Experience in the Construction of Reinforced Concrete Pile Structures indispensable. Each application is to contain full particulars of candidate's qualifications, the amount of the weekly salary required is to be stated therein, and it must be accompanied by copies of three testimonials (which will not be returned). Applications from ex-Service men whose credentials are satisfactory will receive preferential consideration.—Address, 6208, The Engineer Office. 6208 A

## SITUATIONS WANTED

ADVERTISER (23), Good Education, 2 Years Shops, 2½ years R.N.A.S. and R.A.F. as seaplane pilot and technical stores officer, 2 years college, good knowledge I.C. engines, good refs., SEEKS APPOINTMENT.
Address, P4095, The Engineer Office. P4095 B

ARCHITECT and CIVIL ENGINEER, A.R.I.B.A., &c. (37), with 13 years' Indian experience, buildings, DESIRES ENGAGEMENT in India in position of responsibility.—Address, P4117, The Engineer Office. P4117 B

BUYER.—The MANAGER of a Large Engineering Works, purchasing department, who has an extraordinarily wide knowledge of markets, is OPEN to ACCEPT NEW APPOINTMENT for end of September.—Z. M. 613, care of Deacon's, Leadenhall-street, London. 6285 B

CHIEF WORKS ENGINEER (Mechanical and electrical), with twenty years' experience amongst large works plants, DESIRES responsible APPOINTMENT. Salary about £650 p.a.—Write, "C. H. O.," c/o J. W. Vickers and Co., Ltd., 6, Nicholas-lane, London, E.C. 6284 B

CIVIL ENGINEER, B.Sc., DESIRES PRACTICAL EXPERIENCE under civil (for preference) or mech. engineer; young and energetic; good testimonials; living salary.—Address, P4099, The Engineer Office. P4099 B

COMMERCIAL ENGINEER (37), with 20 Years' machine tool and general engineering experience, SEEKS POSITION as MANAGER or similar position of responsibility; has had first-class commercial and managerial training, also selling. Possessed of initiative and organising ability above the average. Would be prepared to reorganise stagnant or decaying business.—Address, 6287, The Engineer Office. 6287 B

DIE CASTING.—A First-class MAN (30), with 7 years' exp. in designing and making of all classes of dies for prod. by pressure and gravity in aluminium and zinc base alloys, conversant with most up-to-date methods adopted in die and casting shops, SEEKS any progressive POSITION.—Address, P4129, The Engineer Office. P4129 B

ENGINEER, A.M.I.C.E., DESIRES EMPLOYMENT. 15 years' first-class experience, including metallurgy, furnace and gas producer design and construction, gas and coke making, steel structural work, building construction, also commercial work and expert. Knowledge of French and good draughtsman.—Address, P4105, The Engineer Office. P4105 B

ENGINEER, A.M.I.C.E., Shortly Commencing practice as consulting engineer in South Wales, PREPARED to ACT as TECHNICAL REPRESENTATIVE for a Firm of repute. Sound experience in modern iron and steel practice, also tin-plate and sheet mills and collieries. London, North of England, and South Wales experience. Good connection with principals.—Address, P4127, The Engineer Office. P4127 B

ENGINEER (24) DESIRES START in D.O. Tech. training at day and evening classes, Polytechnic, diploma; 7 yrs. shops; small wage to commence.—A. L. HANES, 330, Kennington Park-road, S.E. 11. P4120 B

ENGINEER (35), 7 Years Chief D.O., 2½ Years Charge of works, REQUIRES BERTH; experienced switches, crossings, lay-outs, rims, tires, axles, foundry, plant maintenance, &c.—Address, P4126, The Engineer Office. P4126 B

ENGINEER (40), Shortly Disengaged, REQUIRES progressive POSITION. Experience covers practical work, D.O. routine, designing general and special machinery and appliances, complete lay-outs for factories, &c., conducting correspondence, first-hand knowledge of mass production, and supervision of erection and tests of complete plants in general, saw mill, producer gas, motor car and body engineering. Speciality, organisation and efficiency. Will carefully consider any offer.—Address, P4132, The Engineer Office. P4132 B

ENGINEER-DESIGNER (37), Experienced in Heavy oil engines and general marine machinery, DESIRES D.O., Technical or Commercial POST.—Address, P4121, The Engineer Office. P4121 B

ENGINEER, Mechanical 35), B.Sc., A.M.I.C.E., 17 years' experience at home and abroad, marine shop trained, drawing-office, supervision new construction, sales and general commercial experience, SEEKS RESPONSIBLE POSITION as COMMERCIAL ENGINEER. Disciplinarian, hard worker, used to control. Technical correspondent in French and German and fair knowledge Spanish. Public school education.
Address, P4124, The Engineer Office. P4124 B

ENGINEER (35), British, Married, Mechanic, Can prove 20 years' all-round experience, jigs and fixtures, many types of small and medium press tools, &c.; many certificates for draughtsmanship, willing to travel anywhere, unemployed, would LIKE REGULAR WORK; good refs.—67, Gordon-road, Enfield, Middlesex, N. P4104 B

ENGINEER-IN-CHARGE (35), SEEKS RE-ENGAGEMENT; superintend plant maintenance, repairs, new installations. Excellent references.—Address, P4111, The Engineer Office. P4111 B

EMPLOYER WANTED to Give Drawing-office Experience to Young Man of secondary school education and of good mechanical and technical experience. Please help. London district.—Address, P4114, The Engineer Office. P4114 B

MANUFACTURERS, if DESIROUS of NEGOTIATING with an ENGINEER travelling Lancashire, Yorkshire, &c., to undertake some special work, address in first instance, P4128, The Engineer Office. P4128 B

MARINE ENGINEER (Scotsman), 33, Single, abstainer, ten years with B.I.S.N. Co., desirous of giving up the sea, REQUIRES suitable POST or go as partner in any small engineering or repair business in town, coast, or country. Could invest a little and give services.—Address, P4027, The Engineer Office. P4027 B

MECHANICAL ENGINEER, 13 Years' Good General experience as manager and foreman, also costing and travelling, SEEKS responsible POST, any capacity.—Address, P4118, The Engineer Office. P4118 B

MECHANICAL ENGINEER and DRAUGHTSMAN (38), with 22 years' experience in general engineering, machinery, ship repairing, &c., estimating, commercial and correspondence, DESIRES POST as ASSISTANT to WORKS MANAGER or similar responsible position in town or country. Good references.—Address, P4131, The Engineer Office. P4131 B

SCIENTIFIC MECHANICAL ENGINEER REQUIRES SITUATION, home or abroad; experienced in general shop practice, tool work, scientific and optical instruments.—Write, F. COZENS, 1, Belmont-street, London, N.W. 1. P4106 B

## SITUATIONS WANTED (continued)

YOUNG CIVIL ENGINEER (25), Honours B.Sc., DESIRES POST as ASSISTANT CIVIL ENGINEER.—Address, P4123, The Engineer Office. P4123 B

DESIGNER DRAUGHTSMAN REQUIRES SITUATION; 10 years D.O., jigs, press tools; experienced in small automatic work, including typewriters; shop experience; two years chief at last situation.—Address, P4092, The Engineer Office. P4092 B

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For continuation of Small Advertisements see page iii

# The Electrification of the Swiss Federal Railways.

No. I.

BOTH at home and abroad considerable interest has been aroused by the interim report* published by the Electrification of Railways Advisory Committee, which was appointed by the Ministry of Transport. Much attention, particularly abroad, has been attracted by the advocacy of one particular system for the whole of Great Britain, and by the choice of the continuous-current system at 1500 volts. When the final report is published, it is hoped that the evidence will be given on which the findings were based. In the meantime, it appears to be opportune to publish an account of the reasons which led to the proposal of the single-phase system in Switzerland, and to the advocacy of the generation of current for railways at a frequency different from the standard frequency for industrial power, &c.—recommendations quite contrary to those arrived at by the British Committee. As is well known, an official Commission was appointed in 1904 to inquire into the question of the electrification of the Swiss railways. Various reports have been issued by that Commission, the work of which may be said to have culminated at a joint public meeting on December 14th, 1915, arranged by the Electro-technical and Water Power Associations in Switzerland, at which representatives of the Government Departments and the multifarious interests affected by this question were present. At that meeting two papers were read—one by Herr L. Thormann, the chief engineer of the Lötschberg Railway and past member of the Commission; the other by Professor Wyssling, the general secretary of the Commission. In these papers the main findings of the Commission were reported and actual working results as far as available were given. Translations of these papers are reproduced herewith in abstract form, together with additional information which has been courteously supplied by the two authors, who were recently invited to supply any matter supplemental to that contained in their original papers, in order to bring their views up to date.

## I. PAPER BY L. THORMANN, CHIEF ENGINEER OF THE LOETSCHBERG RAILWAY.†

In this paper the technical side of electric traction for main lines is dealt with, in so far as it affects the electrification of the Swiss Federal Railways. Though the decision to proceed with the electrification of the St. Gothard line is of far-reaching economic importance, the fact has not produced so much discussion as the question of the system to be adopted. At the outset, a rapid survey is given of the chief electrified main-line railways, arranged according to system.

For main-line railways, the following systems, named after the mode of supplying energy to the train, come up for consideration:—

(1) Three-phase system at 3000–5000 volts and a low frequency of about 16 cycles per second.

(2) Continuous-current system at 2000–3000 volts.

(3) Single-phase system at 15,000 volts and 15–16 cycles.

Most Swiss generating stations work at frequencies of from 40 to 50 cycles.

All other systems, such as low-tension, continuous-current or three-phase systems, are too uneconomical for main lines.

### (1) THREE-PHASE SYSTEM.

In Switzerland there is the Simplon Tunnel line, about 22 kiloms. in length, working at 3000 volts, 16 cycles. This line was opened in 1906, and at that time no alternative solution for the electrification of the tunnel was possible. The five locomotives of the Federal Railways can cope with the traffic satisfactorily.

In Italy about 280 kiloms. of the State Railways have been electrified, with 3000 volts at 16 cycles. The lines are:—

| | Kiloms. |
|---|---|
| Valtellina | 106 |
| Giovi | 53 |
| Mont Cenis | 49 |
| Savona–Ceva | 41 |
| Monza–Lecco | 38 |

On the Giovi and Mont Cenis lines the traffic is very heavy, and is dealt with by about 150 locomotives of 2000–3000 horse-power. Gradients of 30 in 1000 occur.

With the three-phase system, the lightest locomotives are obtained, namely, 30–40 kilos. per horse-power. This is mainly because the conductor pressure can be applied direct to the motors, thereby dispensing with transformers. The speed control is not ideal, but meets the needs of the service. The great drawback of the three-phase system is the double overhead line, which may become very complicated at points and crossings, and indeed impossible for extensive sidings. For example, the extension of the Simplon overhead system to the Lötschberg line was out of the question, because the collecting bows used in the single-line Simplon Tunnel could not be used in the double-line Lötschberg Tunnel. Modifications of the construction would not overcome all the difficulties. Hitherto, the double overhead line has prevented higher pressures than 3000 volts being adopted.

### (2) CONTINUOUS-CURRENT SYSTEM.

No examples of European main-line railways can be cited.‡ The city and suburban lines of Paris, Berlin, London, &c., work on the low pressures of 600 to 800 volts. North America is really the home of the high-tension continuous-current system of 2000–3000 volts. While some of the electrified railways are inter-urban lines using motor coaches, linking up with tramways, others are equipped for very heavy traffic. The Chicago, Milwaukee, St. Paul Railway, for an electrified section of 182 kiloms., has four sub-stations, each of 4000-kilowatt capacity, converting three-phase energy at 100,000 volts into continuous-current at 3000 volts for the overhead conductor.

Whatever the reasons were which led to the adoption of the continuous-current system in America, the conditions in Switzerland are entirely different. Thus, the Montreal line is an inter-urban railway connecting two fairly large towns, while the Chicago, Milwaukee and St. Paul, and the Butte, Anaconda and Pacific lines run through barren districts in some places at an altitude of as much as 2800 m. Since the sub-stations are about 50 kiloms. apart, it is concluded that there must be one train only at a time between any two sub-stations, and that at a speed of 26 kiloms. per hour, the train will take about two hours to travel from one sub-station to the next. Such conditions are not comparable with Swiss conditions.

Whatever technical demands are entailed, the system appears to be successful. The locomotives weigh 60–70 kilos. per horse-power, compared with 45–60 kilos. per horse-power for 600 to 1500 volts. No pressure transformation being necessary, the equipment is fairly simple. The speed control meets the requirements of the service. Particulars of the chief high-tension continuous-current railways are given in Table I.

TABLE I.—*High-tension Continuous-current Railways in North America.*

| Railway. | Length, kiloms. | Pressure, volts. | Locomotives. H.P. | Locomotives. Weight in tons. |
|---|---|---|---|---|
| Chicago, Milwaukee and St. Paul* | 182 | 3000 | 3400 | 235 |
| Butte, Anaconda and Pacific† | 51 | 2400 | 1050 | 73 |
| Northern Canadian Tunnel Line between Mount Royal and Montreal‡ | 16 | 2400 | 1200 | 75 |
| Michigan–Chicago§ | 148 | 2400 | — | — |

*Added Particulars.*—* The electrical portion now exceeds 1000 kiloms. † Mineral line. This served as an experiment for the above electrification. ‡ Inter-urban line. § Owing to flash-over troubles, from pressure surges, due to third-rail impedance, the voltage has been halved by adding an intermediate sub-station. Originally, sub-stations were 80 kiloms. apart.—ED. THE E.

### (3) SINGLE-PHASE SYSTEM.

Particulars of the chief single-phase railways are given in Table II. The two Prussian railways have

TABLE II.—*Single-phase Railways.*

| Railway. | Length, kiloms. | Pressure, volts. | Frequency, cycles. | Locomotives, H.P. |
|---|---|---|---|---|
| Switzerland— | | | | |
| Lötschberg | 84 | 15,000 | 15 | 2500 |
| Rhætian (Engadine) | 105 (narrow-gauge) | 10,000 | 15 | 6 800 |
| Germany— | | | | |
| Magdeburg–Leipsic–Halle | 154 | 15,000 | 16 | various |
| Silesia (Lauban–Königszelt) | 274 | 15,000 | 16 | |
| Wiesental | 49 | 10,000 | 15 | 1000 |
| Austria— | | | | |
| Mittenwald | 110 | 10,000 | 15 | 800 |
| Hungary— | | | | |
| Budapest–Gödöllöh | 54 | 10,000 | 15 | 500 |
| France— | | | | |
| Midi (Lourdes–Perpignan) | 60 | 12,000 | 16 | 12–1500 |
| Norway— | | | | |
| Rjukan | 46 | 10,000 | 25 | 500 |
| Sweden— | | | | |
| Riksgräns | 130 | 15,000 | 15 | 1700 |
| United States— | | | | |
| New York, New Haven and Hartford | 800 (4–6 lines) | 11,000 | 25 | 12–1500 |
| Pennsylvania | 184 | 11,000 | 25 | — |
| Norfolk and Western | 136 | 11,000 | 25 (1–3 ph.) | 3200 |

steam generating stations, the power being generated at 60,000 and 80,000 volts and transformed down to 15,000 volts in three and four sub-stations respectively. At the outbreak of war, sections of both lines were working, and over 100 locomotives were in use or under construction. Single-phase locomotives differ from those of the other two systems by having transformers for reducing the pressure. Nevertheless, the weight per unit output, at least of European single-phase locomotives, is not greater than that of American high-tension continuous-current locomotives. According to type, this weight varies from 50–70 kilos. per horse-power, while the 1 E 1 Lötschberg locomotive weighs only 41 kilos. per horse-power.

As regards speed control, the locomotives satisfy all demands under the most economical conditions. The Oerlikon motor, as used on the Lötschberg line, is particularly good from the efficiency standpoint. Taking the efficiency as the ratio of the theoretical power at the wheel rims to the power supplied to the locomotive, exhaustive trials have given values of 80–83 per cent. on the inclines and of 79 per cent. for the whole journey and back. On a gradient of 27 in 1000, the efficiency at 300 revolutions per minute was 75 per cent.

### EARLY TROUBLES ON THE LÖTSCHBERG RAILWAY.

Since the initial troubles have been overcome, the technical equipment of the Lötschberg Railway has completely satisfied the requirements of main-line traffic. As these troubles led to the question of the system to be employed on the St. Gothard line being left open for a time, those of greatest moment are enumerated below:—

(1) Insulation faults in the overhead conductors mainly in the tunnels, were overcome by improving the insulation at the points of suspension. The average number of faults per month has been reduced thereby to one-fifth in the open and to one-tenth in the tunnels. Most of the breakdowns in the tunnels occurred when the snow melted in spring time. Birds also caused troubles—in 1915 sixteen cases were due to them alone.

(2) Insulation failures in the locomotive transformers were prevented by increasing the insulation, particularly where the high-tension was led in; and in the motors by rendering the commutator dust harmless. The monthly failures in the transformers were thereby reduced to one-seventh, in the motors to one-ninth, and in the other high-tension apparatus to one-fifth.

(3) Failures in the driving gear of the locomotives were remedied by strengthening individual parts, such as the crank pins and Scotch yokes, and by introducing an elastic member between the motors and the driving wheels. The former alterations were made in all, the latter only in six of the locomotives, but disturbances nearly disappeared. Failures in the drives, gears and jack axles per month fell from 2.4 in 1913 to 0.8 in 1915, the latter being mostly due to hot bearings. No further failures of crank pins have been reported.

As regards punctuality of trains, the Lötschberg figures are as good as those of the Federal Railways. The upkeep of the locomotives is quite satisfactory, despite earlier fears on this point. Experience has shown that 400,000 kiloms. can be covered before 0.5 mm. has to be turned off a commutator, while a carbon brush will last 250,000 kiloms. After 400,000 kiloms. the gears show no appreciable sign of wear. Such costs are therefore quite unimportant, and in no case greater than for continuous-current motors. These successes are due to the zeal of the respective staffs, aided by engineers of the Oerlikon Works—the firm responsible for the locomotives—of the Swiss Locomotive Factory, Winterthur, and of Messrs. Brown, Boveri and Co.

### SUMMARY OF RESULTS.

(1) At the outbreak of war the electrified main lines belonged mainly to the Italian and the Prussian State Railways, the former electrified by the three-phase, the latter by the single-phase system. Technically, both systems have been successful.

(2) In no other European country does there appear to be any desire to follow the Italians. The tendency is rather in the direction of high-tension single-phase current as used on the Bernese Alpine Lötschberg Railway.

(3) In America the three-phase system is practically unknown. The single-phase is used with success on sections serving wide areas, and of late the high-tension continuous-current system has been adopted. The applications of the last-mentioned system, however, are few in number, and relate to services so different in their requirements from those existing in Switzerland that they need hardly be considered.

Technically, it can be said that all three systems can be made satisfactory, but that the three-phase system—on account of the double overhead conductor—would be used only if neither of the others existed. This was really the case when the Italians began to electrify their railways. For Switzerland, therefore, it is a question of single-phase or continuous current, and the choice will mainly depend on economic conditions.

* See THE ENGINEER, Vol. 130, p. 331.

† See *Bulletin* of the S.E.V., 1916, Part I.

‡ Though 1200 and 1500-volt continuous-current railways exist in Europe, some of which have been opened since the above report was made, the author appears to consider only high-tension systems of 2000 to 3000 volts.—ED. THE E.

## Developments in Power Station Design.

No. XL*

A LOW-TEMPERATURE carbonisation plant has been designed by Mr. C. W. Tozer, A.M.I. Mech. E., for the South African Carbide and By-products Company, for the manufacture of carbide of calcium. The function of the first-mentioned portion is to utilise, as far as possible, the valuable by-products contained in the coal by subjecting it to low-temperature carbonisation. The resultant low-temperature fuel is to be gasified in a recovery producer plant, and the gas will be used for firing the boilers associated with the electric generating plant.

Wagons running on a 3ft. 6in. gauge railway track deliver the coal from a mine near by into an elevator pit shown in the drawing—Fig. 56—and it is then elevated to the coal storage bunker. The carbonising plant consists of twenty-four vertical Tozer retorts having a maximum capacity of 120 tons of coal per twenty-four hours. The retorts—see Fig. 54 —are set in a bench, 75ft. long by 17ft. deep by 23ft. high, at the level of the charging stage, and they are carried by sole plates, to which the locking and operating gear for the bottom covers is attached, the whole of the setting being supported by stanchions and joists. The stanchions also serve for supporting the charging stage as well as the two intermediate stages, from which the gas supply to the setting is regulated. The retort setting is of the regenerative type, the heating gases after leaving the retorts on the way to the chimney passing through a series of flues where a portion of the sensible heat is given up to the secondary air supply, the setting being heated by a mixture of low-temperature gas and producer gas.

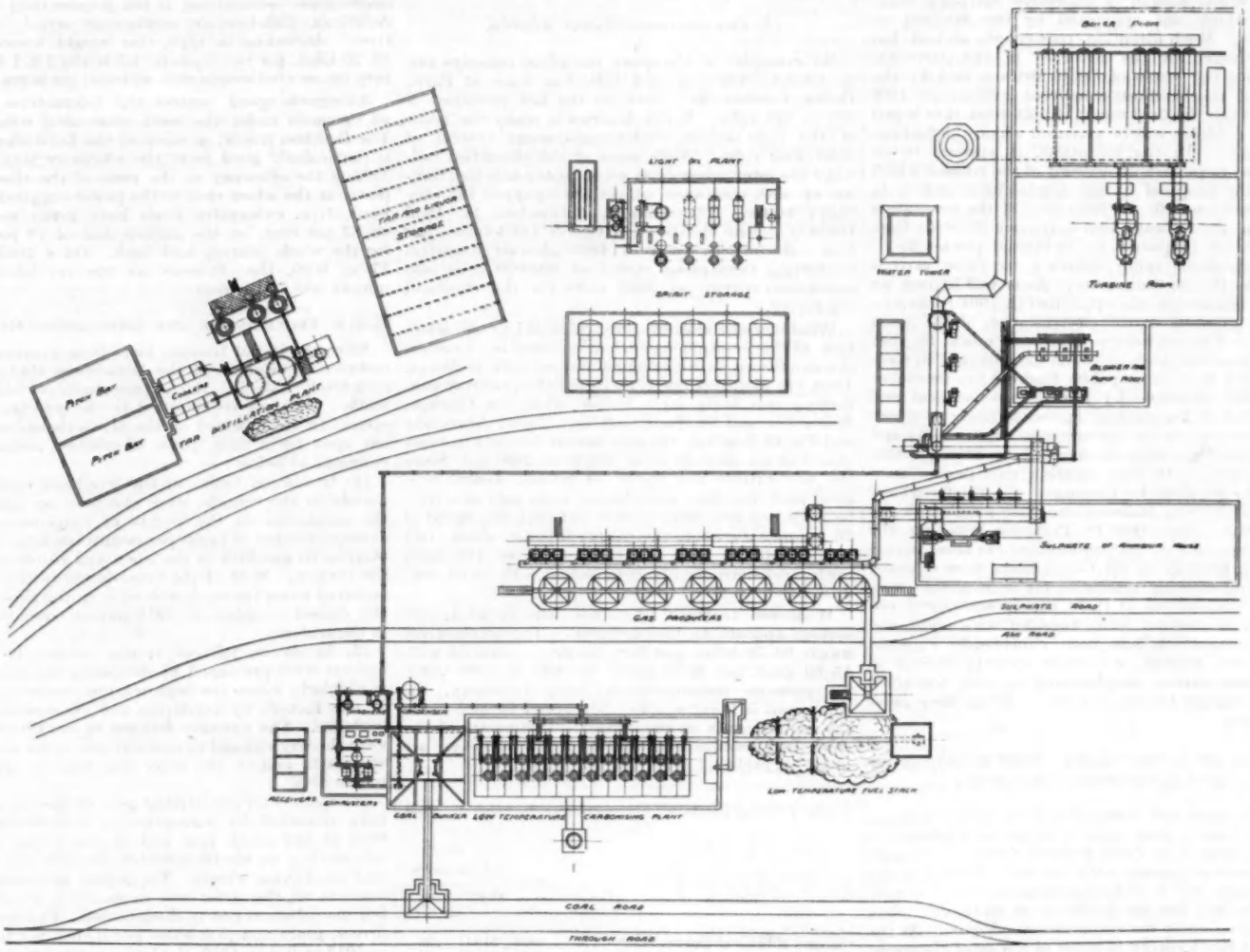


FIG. 53—LOW-TEMPERATURE CARBONISATION POWER PLANT FOR NATAL

at Ballengeich, Natal. The retorts and the steam turbine and electrical plant associated with the undertaking have been constructed at the Fraser and Chalmers Engineering Works, belonging to the General Electric Company, and Harper Brothers and Co. are the consulting engineers. The complete installation, which is now being erected and which is shown in Fig. 53, comprises, in addition to the low-temperature carbonisation plant and electrical generating plant, a gas producer installation and a factory

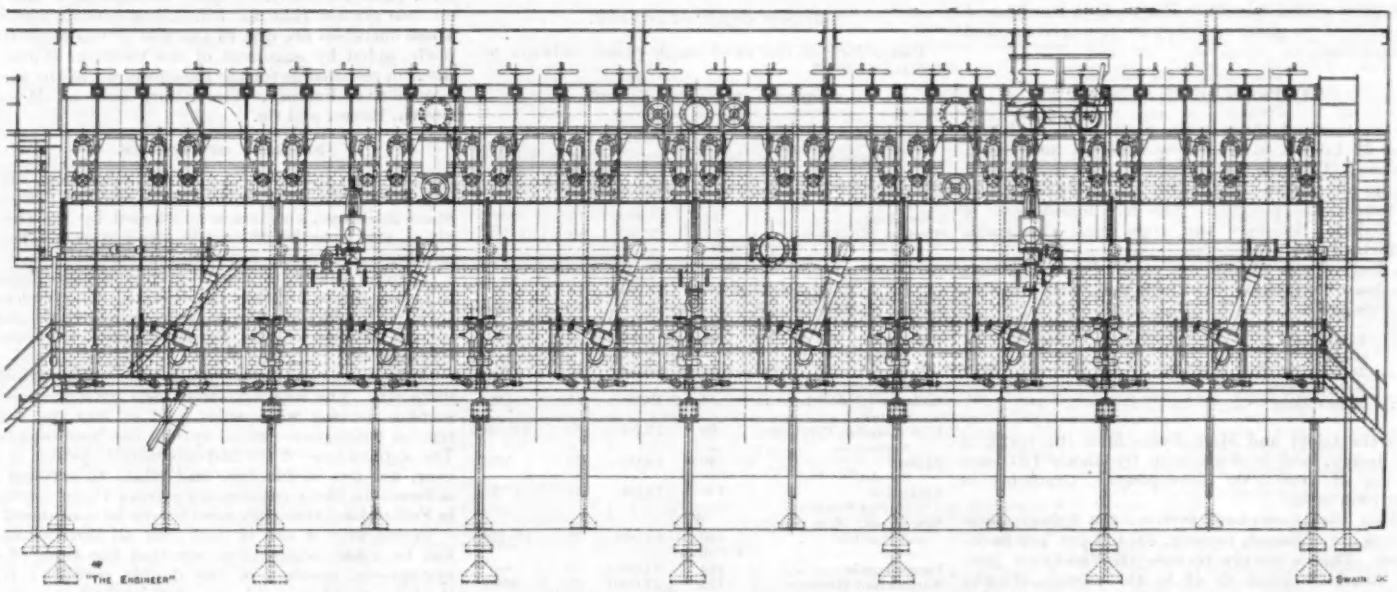


FIG. 54—SET OF VERTICAL TOZER RETORTS

Owing to the low temperature employed, cast iron boxes are used for the recuperator. From the drawing—Fig. 56—it will be seen that the overhead storage bunker, which has a capacity of 175 tons, has two discharging chutes, through which the coal passes, whilst filling the hopper type charging wagons, which run along on top of the retorts on 36in. gauge tracks. Fig. 55 shows the construction of a retort head and its locking gear.

All the retort plant is housed in a steel building, 88ft. long by 32ft. wide and 34ft. high at the eaves.

* No. X. appeared September 23rd.

A crane rail has been placed on each side of the building to carry a hand-operated traveller crane for erecting the plant. The low-temperature fuel is discharged on to a sloping hearth underneath the retorts, where it is raked down to a conveyor, a little below the ground level, which runs the full length of the retort bench, and finally delivers the fuel to storage

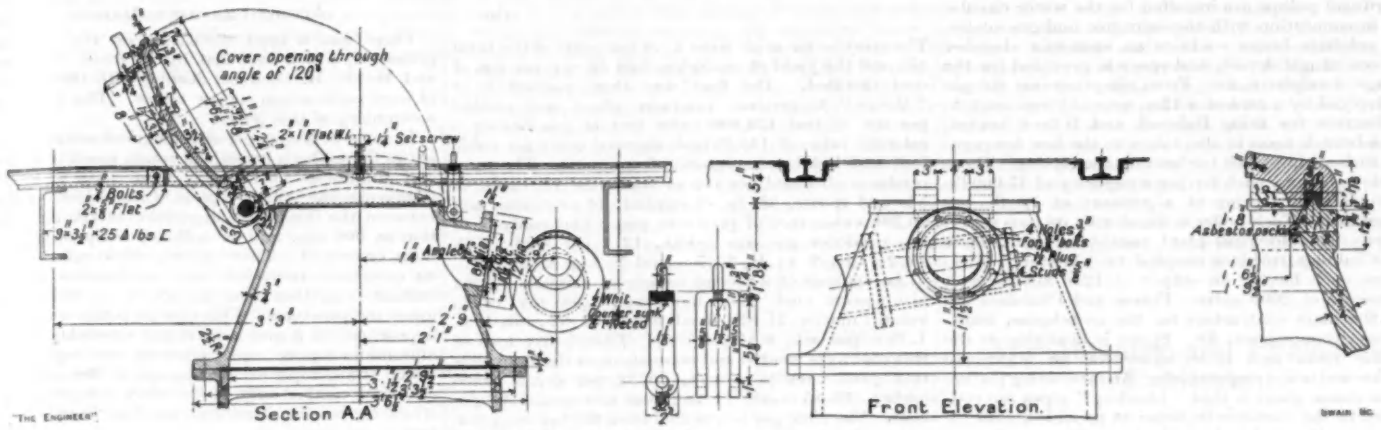


FIG. 55—DETAILS OF RETORT HEAD AND LOCKING GEAR

dumps or on to a chute supplying the elevator, which handles the fuel for the gas producers. All the gases evolved during carbonisation are collected in a main to which each retort is coupled by 7in. cast iron pipes, and the gases are then exhausted into a condenser consisting of a mild steel shell with tube plates at the top and bottom, connected by a number of steel tubes, the cooling water passing upwards in the opposite direction to the gases. The tar and liquor overflow from the condenser through a seal pot into an underground separator and receiver. For creating the suction for drawing the gases from the retorts through the condenser a Bryan Donkin exhauster plant is provided, and it is housed in a steel building situated at the end of the coal bunker stage. It consists of two steam-driven exhausters, controlled by means of hydraulic regulators acting on the steam valves. Each exhauster, which is designed to pass 700,000 cubic feet of gas per twenty-four hours, is directly coupled to a horizontal steam engine erected on a continuous bed. The gases pass onwards from the exhauster to a tar extractor, where the light tar and tar fog, which have escaped removal in the condenser, are removed.

This tar extractor, which is shown in the drawing, Fig. 58, is a Pelouze and Audouin extractor, made by W. C. Holmes and Co., Limited, of Huddersfield. It consists of an outer cast iron casing divided into two compartments—an upper and lower compartment. The latter constitutes the pedestal of the machine, and also the gas inlet chamber, whilst the upper portion forms the outer wall of the tar seal, in which the drum works, and it also forms the gas outlet chamber in which the gas is collected after passing through the plates of the drum. A manhole of ample size is provided, through which the removable plates of the drum may easily be withdrawn. The drum itself consists of a single horizontal malleable iron octagonal plate, to the underside of which are bolted malleable iron corner posts, which form the frame for the sets of removable vertical plates. There are six sets of these depending plates, each set consisting of six plates, which are punched alternately with slots and holes. The drum formed in this manner, which has a tar seal at its lower extremity, gives a wire-drawing effect to the gases, and the tar is thereby separated from the gases. It will be perceived that the drum is suspended over an inner cylinder by a chain passing over the periphery of a wheel mounted on a horizontal shaft, and the ends of the shaft also carry wheels to which balance weights are attached by means of flexible wire cords. The height of the drum in the casing therefore varies with the volume of gas, and consequently the exposed area of the depending plates, forming the drum, also varies with the volume of the gas. Loose balance weights are supplied, so that the back pressure in the apparatus may be varied to suit requirements. The top horizontal octagonal plate of the drum is fitted with safety valves, which open automatically and by-pass the gas in the event of the balancing arrangements being disturbed. Overflow and run-off pipes are provided, and also a seal pot, as partially shown.

The exhauster house also accommodates the tar and liquor pumps, and the wash-oil circulating pumps, both being in duplicate and driven by belting from overhead line shafting, which is driven in turn by an electric motor. Next, the gases pass to two washers of the vertical centrifugal type, arranged in series, one washer removing the ammonia by means of a water spray, whilst the other, which is supplied with wash oil, absorbs the light hydrocarbons in the gases. Both washers, which are electrically driven, are being supplied by Kirkham, Hulett and Chandler, Limited. The washers consist—see Fig. 57—of a vertical cylindrical cast iron vessel divided into a number of chambers through which a vertical shaft passes and to which are attached spraying devices for lifting and spraying the washing liquid so as to bring it into intimate contact with the gas. These chambers consist of specially designed trays, having perforated rims, the size of the perforations varying according to the impurities to be extracted, and bent perforated tubes depending from the undersides of the trays in the manner sown. The shaft and trays are revolved at a speed of from 100 to 150 revolutions per minute, and as they revolve the liquid is forced through the bent tubes through the perforations in the tubes and into the trays, through the perforated rims, across the gas space and on to the vessel walls, from which it rebounds, and again comes into contact with the gas. The gas is admitted to the lowest washing chamber, from which it passes, through the spray, to the central opening in the bottom of the second washing chamber, then through the spray into the third chamber, and so on throughout the vessel. The washing liquid is admitted at the top of the casing, and flows through the centre openings from chamber to chamber, and is finally run off. If at any time it is desired to concentrate the strength of the liquid, the supply may be reduced or shut off, when the spraying effect is maintained as efficiently as with a continuous supply.

After leaving the recovery plant the gases are mixed with the producer gas, whilst the tar and liquor are delivered to their respective storage tanks, the tar being distilled for the recovery of the various products, such as light spirit, illuminating oil, fuel oil, road tar, pitch, &c. Having been used for stripping the gases, the wash oil is delivered to a light oil plant consisting of crude, rectification, and fractionating stills, oil exchange heaters, an acid and alkali washer, pumps, &c. The refined motor spirit passes to storage tanks ready for sale, and the clean wash oil is led to a cooler, where the temperature of the oil is reduced to that of the atmosphere, when the oil then passes into circulation again.

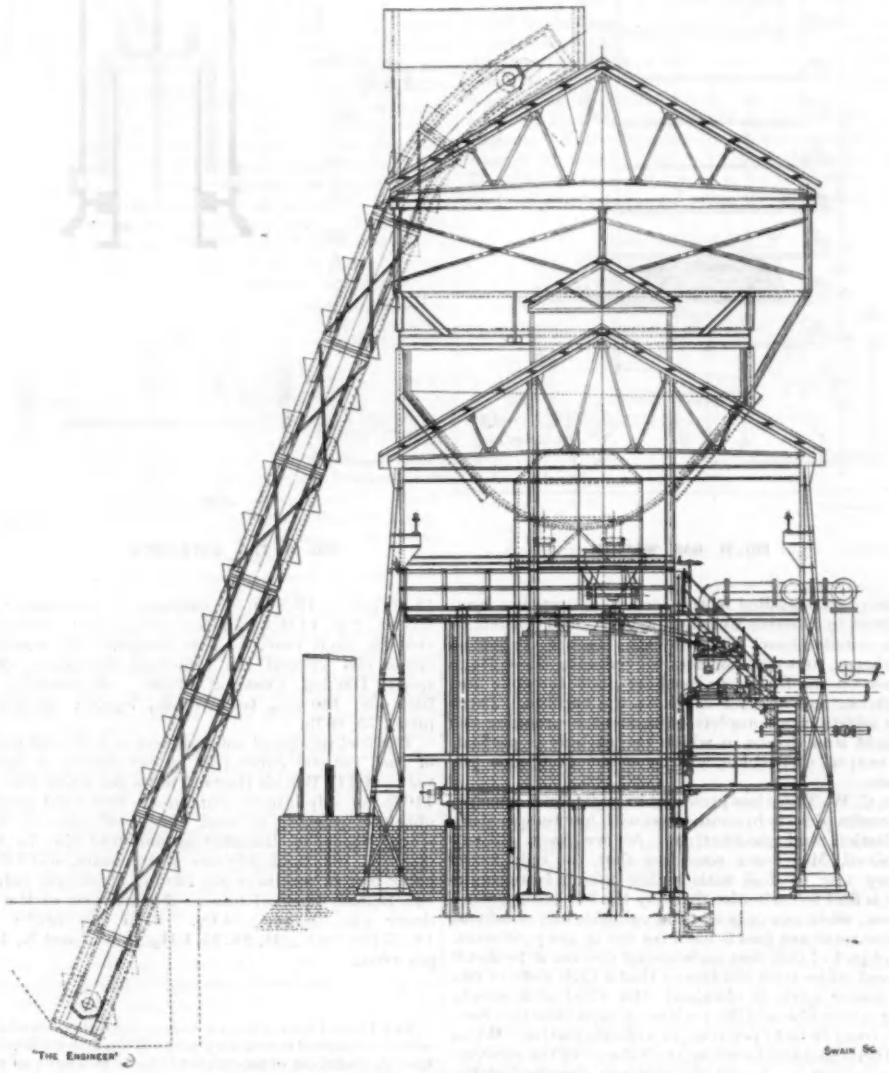


FIG. 56—END ELEVATION OF RETORTS AND COAL BUNKER

The tar distillation plant is of the semi-continuous type, consisting of two pot stills working in conjunction with a continuous tar dehydrator, condensers, pitch coolers, receivers, pumps, &c. The tar and liquor are stored in underground concrete tanks.

The conveyor which deals with the low-temperature fuel delivers the fuel on to a storage heap, or it

can be delivered by means of a chute on to an elevator, which delivers it to a longitudinal conveyor extending along the full length of the gas producer plant. There are seven gas producers, each 10ft. in diameter and 10ft. high, and the plant is arranged for the recovery of ammonia, the gas passing successively through a mechanical washer, an ammonia absorber, and a combined saturator, and finally through a gas cooler. Three turbo-blowers and three electrically driven centrifugal pumps are installed for the water circulation in connection with the saturator and gas cooler. The sulphate house contains an ammonia absorber and centrifugal dryers, and space is provided for the storage of sulphate, &c. From the producers the gas is conveyed by means of a 42in. wrought iron main to the burners for firing Babcock and Wilcox boilers, and a branch main is also taken to the low temperature carbonising plant for heating the retorts. There are three boilers, each having a capacity of 17,000 lb. per hour and working at a pressure of 180 lb. per square inch. Each boiler is fitted with its own superheater. The electrical plant consists of two Fraser and Chalmers turbines coupled to "Witton" alternators, each having an output of 1250 kilowatts at a pressure of 2000 volts. Fraser and Chalmers are also the main contractors for the switchgear, transformers, economisers, &c. Space is available in the turbine room and boiler-house for an additional turbine and boiler respectively. An interesting feature of the steam plant is that "bleeding" pipes are connected to the turbines in order to provide steam for saturating the air blast for the by-product producers. The exhaust steam from the turbo-blowers and other steam auxiliaries is also used for this purpose.

plant; 36.8 lb. of ammonia; and 16 cwt. of smokeless fuel. An analysis of the dry crude oils is given below:—

| | Per cent. |
|---|---|
| Fraction below 170 deg. Cent. | 5 |
| 170 deg. to 230 deg. | 17 |
| 230 deg. to 270 deg. | 15 |
| 270 deg. to 330 deg. | 20 |
| 330 deg. to 365 deg. | 12 |
| Bituminous pitch | 31 |
| | 100 |

The cresylic tar acids were 17.4 per cent. of the total oils and the yield of smokeless fuel 16 cwt. per ton of coal distilled. The fuel was then gasified in a "Moore" by-product producer plant and yielded per ton of fuel 124,000 cubic feet of gas having a calorific value of 145 British thermal units per cubic foot and 106 lb. of sulphate of ammonia. The total products obtained per ton of coal were 17.7 gals. of oils and spirits, 121 lb. of sulphate of ammonia, and 90,200 cubic feet of producer gas. The analysis of the producer gas was:—$CO_2$, 12.1 per cent.; CO, 18.2; $CH_4$, 1.4; H, 23.7; and N, 44 p.c. (by diff.).

An analysis of a second sample of strongly coking bituminous coal gave moisture, 2.08 per cent.; volatile matter, 31.83; fixed carbon, 55.92; nitrogen, 1.75; and ash, 8.43 per cent. Twenty-five tons of this coal were treated and an analysis of the smokeless fuel gave volatile matter, 10.34 per cent.; fixed carbon, 75.45; ash, 12.26; and nitrogen, 1.93 per cent. The yield per ton of coal from the low temperature carbonisation process in this case was 16.42 gals. of water-free crude oils and 2.25 gals. of motor spirit from the stripping plant, making a total of

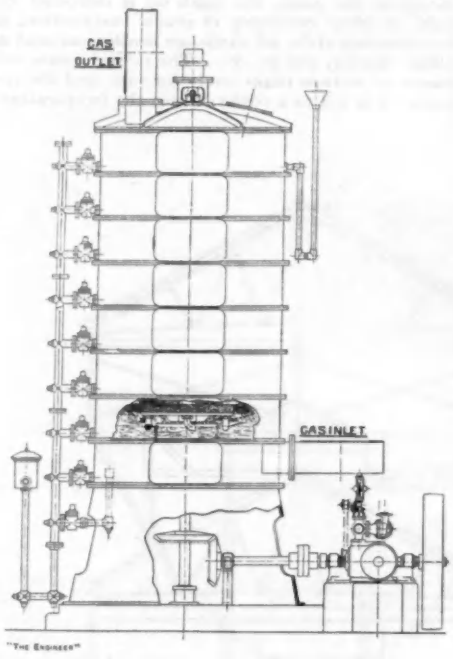


FIG. 57—GAS WASHER

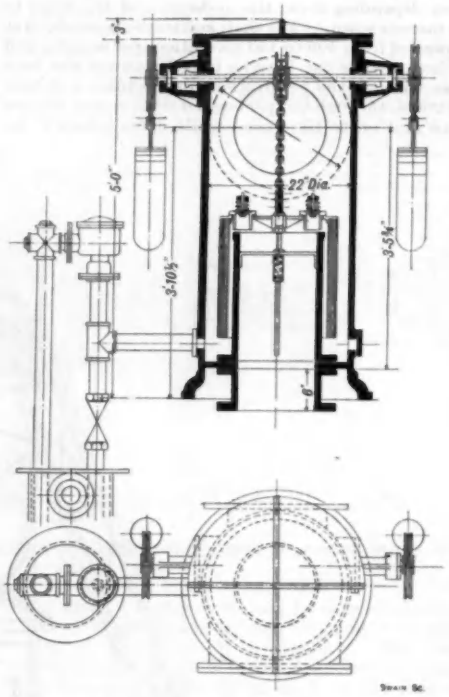


FIG. 58—TAR EXTRACTOR

The plant installed in the carbide factory has been designed by Charles Bingham and Co., and consists of three single-phase 800-kilowatt electric furnaces, switchgear, and transformers for reducing the voltage for use on the furnaces, crushing plant for coke and limestone, and also for crushing the carbide. There is, in addition, a complete equipment for making the wrought iron drums in which the carbide is packed. The output of carbide will be about 4200 tons per annum.

Mr. C. W. Tozer has provided us with some interesting results of tests in connection with low temperature distillation and gasification. As we have already explained, Mr. Tozer considers that the only satisfactory way to deal with highly coking bituminous coals is first to carbonise them by the low temperature process, when not only are the valuable oils obtained, but the resultant fuel is ideal for use in gas producers. The object of this first carbonising process is to distill the coal under such conditions that a high yield of oils and motor spirit is obtained, the yield of ammonia being rather low and the residue of smokeless fuel contains from 10 to 12 per cent. of volatile matter. When this fuel is gasified, however, the balance of the recoverable nitrogen is secured as ammonia, together with a good yield of producer gas having an average calorific value. An analysis of a sample from 22 tons of bituminous coal which was treated gave the following results:—Moisture, 2.34 per cent.; volatile matter, 25.19 per cent.; fixed carbon, 53.65 per cent.; and ash, 19 per cent. The corresponding figures for the smokeless fuel were 3.7, 9.85, 63.11, and 23.34 per cent. respectively. The low temperature carbonisation process gave the following yields per ton of coal:—15.2 gals. of crude oils with a specific gravity of 1.042; 2.5 gals. of motor spirit from the gas stripping 18.67 gals.; 19.8 lb. of sulphate of ammonia; and 15 cwt. 2 qr. 11 lb. of smokeless fuel per ton of treated coal in each case. Upon analysis the water-free crude oils yielded the following fractions:—Motor spirit, 160 deg. Cent., 3.12 gals.; illuminating and fuel oils, 160 deg. to 325 deg., 8 gals.; bituminous pitch, 75.40 lb.

The fuel produced was gasified and yielded per ton of fuel 145,000 cubic feet of gas having a calorific value of 147 British thermal units per cubic foot, and 110 lb. of sulphate of ammonia. The total products obtained per ton of coal were 5.37 gals. of motor spirit, 8 gals. of illuminating and fuel oils, 75.40 lb. of pitch, 104 lb. of sulphate of ammonia, and 115,000 cubic feet of producer gas having a calorific value of 147 British thermal units. An analysis of the producer gas showed:—$CO_2$, 12.25 per cent.; CO, 19.25 per cent.; H, 24.55, $CH_4$, 1.10; and N, 42.85 per cent.

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THE United States Senate Commerce Committee having recently reported favourably on the Bill which would permit the establishment of foreign trade zones in American ports, the National Free Zone Association is preparing to conduct an active campaign in behalf of the adoption of the measure as an amendment to the new Tariff Bill. The Bill would permit foreign and domestic merchandise of every description, except such as is prohibited by law, to be brought into the country through the foreign trade zones and there stored, exhibited, broken up, repacked, assembled, distributed, sorted, refined, graded, cleaned and mixed up with other merchandise or otherwise manipulated, and then exported without going through the Customs House. American shipping and commercial interests have long advocated the establishment of such zones with a view to facilitating the development of foreign trade.

# Institute of Metals.

## AUTUMN CONFERENCE IN BIRMINGHAM.

No. II.*

As stated in our last issue, six papers were taken for discussion at the Birmingham meeting of the Institute of Metals last week.

### ALUMINIUM-COPPER ALLOYS.

There was a brief discussion on the first paper presented, which was that by Professor A. A. Read and Mr. R. H. Greaves, dealing with the properties of some aluminium-copper alloys. The following is a summary of this paper.

In some of the copper-rich nickel-aluminium-copper alloys the alpha solution will retain much more nickel and aluminium at 900 deg. Cent. than at ordinary temperatures. Alloys typical of the region comprised between the limits of composition of the alpha solution at 900 deg. and at ordinary temperatures have been examined. These alloys, while relatively soft on quenching from 900 deg., are hardened by slow cooling from that temperature or by re-heating to lower temperatures. This change is the result of the appearance of a new constituent (probably a nickel-aluminium-copper solid solution), the separation of which is accompanied by changes in the density and electrical conductivity of the alloy in addition to its effect on tensile, hardness, notched bar, and other tests.

Dr. Rosenhain, who, in conjunction with Mr. Archbutt and Dr. Hanson, is presenting a report to the Institution of Mechanical Engineers at the end of October dealing with the alloys of aluminium, regarded the paper as a valuable contribution to the literature of the subject. The fact brought out that this group of alloys hardened by quenching and tempering was, Dr. Rosenhain stated, true of a number of alloys.

More than one speaker—the President, Vice-Admiral Goodwin, among them—asked for more information. The points referred to in this connection were the coefficient of expansion, ignorance concerning which might prove a source of trouble in actual practice, and the time and temperature of annealing. It was not possible in the time at disposal to deal with all the questions asked, but Mr. Greaves stated that the minimum annealing temperature was 300 deg. Cent., and the maximum time three to four days.

### ADMIRALTY GUN-METAL.

The contribution by Mr. R. T. Rolfe dealing with the effect of an increasing percentage of lead upon the properties of gun-metal opened up a somewhat lively discussion.

An abstract of the paper is appended.

The effect of lead upon Admiralty gun-metal has been studied by the production of synthetic alloys containing gradually increasing proportions of lead up to 1.68 per cent., subject to control as regards compositions, casting temperatures, and general conditions. In sand-cast gun-metal, lead gradually increases the strength, ductility and softness of the alloy up to about 1.5 per cent. of lead, but above this proportion causes a decrease in all three. Maximum repeated impact resistance is obtained with 1 per cent. of lead, falling away when this figure is exceeded. In chill-cast gun-metal, the effect on the hardness parallels that of the sand-cast metal, with a change point at about 1.5 per cent. of lead, but associated with a minimum rather than a maximum strength figure. Increasing lead proportionately decreases the ductility and also the impact figure of the metal twice melted, that melted once giving more irregular results.

Vice-Admiral Goodwin took exception to the suggestion that the proportion of lead permitted by the Admiralty specification might be increased. The reason for Admiralty restrictions as to the lead content was, he said, a sound one, as gun-metal tended to lose its ductility under high temperature conditions. The tendency in modern marine engineering was to employ increasing degrees of superheat, and any latitude in regard to the lead content of Admiralty gun-metal might set up dangerous conditions.

Dr. F. Johnson expressed the gratitude of foundrymen for the work done by the author. He noted a change of opinion on the part of Mr. Rolfe as to the permissible percentage of arsenic, which he had now increased to 0.5 per cent. It was a somewhat curious fact, however, that arsenical gun-metal of practically the same composition and power at the same temperature had been shown by Mr. Rolfe in the present and a previous contribution to possess different mechanical properties. A subsequent speaker, Mr. J. S. G. Primrose, dealt with the influence of arsenic, and was inclined to challenge the author's statement that 0.5 per cent. of arsenic would not cloak the effect of lead additions. The suggestion that the Admiralty specification might be relaxed as regarded lead content was apparently based on figures for ductility and strength obtained from specially cast test bars. He would point out, however, that notwithstanding the fact that the impact figures were greatest with 0.86 per cent. of lead in the sand-cast bars, the highest values for the chilled cast bars were obtained

* No. I. appeared September 23rd.

from those with the lowest lead content. He would also point out on the author's own evidence of lead segregation that it was extremely difficult to find by analysis all the lead present in gun-metal.

Mr. Rolfe, who will reply more fully by correspondence, assured the President that it had not been his intention to throw a metallurgical brickbat at the Admiralty. He had, however, found what he regarded as good evidence that it was not so necessary to eliminate the lead from gun-metal as was generally believed. He would at the same time point out that gun-metal of whatever composition was hardly suited for exposure to superheat.

### BRASS INGOTS.

The little note which was brought up by Mr. R. Genders on the casting of brass ingots, and which is the result of work done in the research department of Woolwich Arsenal, opened up a topic of practical interest.

In experiments which were carried out to minimise the occurrence of non-metallic inclusions in brass, a form of ingot was adopted whose length was not great in proportion to the cross-sectional area. The ingots made were 3in. square and 30in. in length, as compared with the ingots 6ft. to 7ft. in length and 1½in. square section in common use. Steel-making practice was followed in introducing a hot sinking head or "dozzle." The molten brass was poured through the dozzle, which was filled to the top. No pipe was formed in the ingot proper, and additions of metal were made at any time to the metal in the dozzle without risk of introducing defects into the ingot, any dross rising to the top of the still fluid head. The moulds were tapered, the top being enlarged by increasing amounts in successive experiments, and ingots were cast at the usual foundry speed. It was found that with a mould 3½in. square at the top, tapering to 3in. at the bottom, no shrinkage cavities were formed, and the ingot appeared to be practically perfect as regards soundness. By these methods, failures which previously reached large percentages were reduced to practically nil.

Dr. Rosenhain thought that the investigation confirmed the correctness of a suggestion he had made long since that the attempt to divorce the ferrous from the non-ferrous metals in research work was a mistake. As in iron and steel practice, the troubles which arose could generally be traced back to the original ingot, and that point had been clearly brought out by Mr. Genders. If the ingot was defective, the product would be defective, particularly if much work had had to be done upon it. Attention should be given to the rate of pouring so as to avoid the creation of cavities. That was impossible with a long and narrow mould.

The need of imitating steel works practice was also insisted on by Mr. T. G. Bamford. He admitted the difficulty of doing so in a brass foundry, and there was, in addition, the conservatism of the average caster to be overcome. Something must be done, however, to get rid of blowholes and non-metallic inclusions. One of the remedies was high temperature of pouring, which applied with special force to 70 : 30 brass. In the case of this brass, Mr. R. J. Redding said he had obtained evidence that what impurities were present came from the mould. He agreed that great importance attached to the use of a high temperature in pouring, and it was necessary to teach casters to get the right temperature and then to pour at the correct speed.

Before the author replied, Mr. H. Moore, who has been closely associated with the work, said he could confirm the experimental results stated by the author. In a very brief rejoinder to some of the comments made, Mr. Genders referred to satisfactory results from the use of a ladle for bottom pouring at a temperature of 1200 deg. The narrow mould which had been condemned might not be unsatisfactory under all conditions. Much depended on the mechanical properties specified for the metal.

### COPPER-ZINC ALLOYS.

A short abstract of his paper on the density of copper-zinc alloys was presented by Mr. T. G. Bamford.

The density of alloys, the author pointed out, was important both from a theoretical and a practical standpoint. When the correct density was known, it was possible to determine whether casting conditions had been satisfactory. Hitherto no trustworthy determinations of the densities of the copper-zinc series had been available. The author, after reviewing earlier work, recorded experiments conducted with alloys made from pure metals, and cast in sand and chill moulds respectively. The results indicated that there was a contraction in volume (*i.e.*, increase of density) due to alloying with mixtures containing more than 25 per cent. of copper; and that the density of the sand cast (or slowly cooled) alloys was generally less than was the case with the chill castings, but at points where the liquidus and solidus coincided on the constitutional diagram, chill castings and sand castings gave the same values.

Professor Thos. Turner said it was a somewhat remarkable fact that density determinations of alloys had hitherto been barren of results. Nor did he think anything really useful would be obtained from the work described. It was necessary to know the exact composition of the material and the precise conditions under which it had been produced to open up a field for useful work on density.

Dr. Rosenhain, in the belief that a knowledge of the density of alloys is of much more importance than was formerly the case, was disposed to welcome the paper. If the determinations for density could be accepted, and if it were possible to determine the density of castings, that would be of practical value. It was quite true that the work which had been done so far in connection with density of alloys had yielded no results worth mentioning. He suggested, however, that the investigations now in progress as to the distribution of the atoms in the crystals of metals and the knowledge which was being accumulated as to the structure of matter gave a fresh aspect to questions connected with the density of materials. Research directed towards that end would be of considerable value in extending knowledge of the new conceptions in physics and the extent to which these ideas could be applied to intercrystalline compounds. It was, however, essential that the work on density of metals should be done with greater accuracy. Care must be taken to ascertain that the alloys which were the subject of experiment were in a state of physical and chemical equilibrium.

### PHYSICAL PROPERTIES OF LOW-TIN BRONZE.

A paper was presented by Mr. W. E. Alkins and Mr. W. Cartwright dealing with the effect of progressive cold drawing upon some of the physical properties of low-tin bronze.

An abstract is appended.

The paper gave the results of an inquiry into the effect of progressive cold-drawing upon the tensile strength, specific volume and scleroscope hardness of a bronze with rather less than 1.0 per cent. of tin. It was not found possible to get the three samples of metal used from the same billet, with the result that the tin content varied from about 0.7 to about 1.0 per cent. in the three samples studied, thus precluding a very rigid comparison of the results for the three series. One sample was heavily drafted from a ⅜in. bolt; another was lightly drafted from a bolt of the same diameter, while the third was heavily drafted from a $^{9}/_{16}$in. bolt.

The results showed conclusively that the variation in physical properties with reduction was very different at different stages in the reduction. The most important and rapid changes in properties occurred after a reduction of 85 per cent. of the original area; it was precisely over the range where practical difficulties were met with during drawing that the most pronounced variation in properties was found.

Professor C. H. Desch welcomed the paper, which followed one by Mr. Alkins, as giving useful information on a somewhat complex subject. The specific volume increases with reduction of area were of a gradual character, and gave indications that the work had been carefully done. The sudden increase at the end of the curve was no doubt due to overdrawing. The critical point was at about 85 per cent. reduction. It would be interesting to know if the authors had taken the time factor into account.

The specific volume changes were also the subject of comment by Dr. Rosenhain as being the most interesting feature of the results. It was somewhat remarkable that at a certain stage of cold working the density decreased instead of increasing, as would have been expected. It might have been anticipated that the behaviour of copper would have been duplicated in the copper alloys under similar treatment, but that was shown not to be the case. He hoped that the work would be continued.

Dr. F. C. Thompson, speaking from actual knowledge of the work, referred to the care with which it had been carried out. Stress might be laid on the critical point which had been found, and he could not agree that, as Dr. Desch had suggested, overdrawing was the explanation. Nor was the suggestion that the changes in the specific volume at later stages of reduction were due to want of equilibrium in the material one which could be accepted. Every material which had been investigated showed a similar change, and Longmuir had found the same sort of thing in iron wire. The critical point found was, he believed, an inherent portion of the curve of reduction for any material, and he suggested the real explanation to be that in the actual drawing something in the nature of cones of maximum stress were produced, and that at certain points these cones met and the critical change occurred.

### COPPER WORKING.

After the brief presentation of a paper by Dr. F. Johnson describing experiments on the working and annealing of copper, the Conference adjourned until the following day.

An abstract of the paper is given below.

The paper was divided into three sections. Section I. furnished evidence in favour of the probability that the "critical ranges of deformation," previously discovered and shown in strength-reduction curves, &c., resulted from stages of abnormal plasticity during rolling of the metal. It was suggested that during these stages the metal actually lost some of the increase of hardness conferred in earlier "passes."

The volume changes which took place showed a decrease of volume up to 85 per cent. reduction. There was a maximum specific gravity at that point. The increase of volume which then set in might correspond to the inception of permanent disability in the metal, which, as was shown in Section II., could not be eradicated by annealing. Section II. described annealing experiments on copper strips representing successive stages of reduction from 18 to 98 per cent. At 200 deg. Cent. for one hour unmistakable softening occurred in all strips rolled beyond 40 per cent. reduction, the most severely worked strips showing the greatest amount of softening. It was shown that test pieces taken from the axes of the strips underwent softening to a greater extent than edge specimens from the same series when annealed under the same conditions, thus indicating a greater intensity of strain at the centre than at the edges. High-temperature annealing (750 deg. Cent.) showed that at 87 per cent. reduction a rapid decrease in strength set in and values as low as 9.4 tons per square inch were obtained with air-annealed specimens. Section III. dealt with the low-temperature annealing of cold-drawn copper rods of varying compositions. "Tough-pitch" arsenical rods retained their strength practically unimpaired up to 300 deg. Cent., whereas "tough-pitch" electrolytic copper underwent considerable loss of strength.

## The Shipping and Engineering Exhibition.

No. IV.*

### FLOW METERS.

Besides a large collection of electrical instruments suitable for various purposes, the Cambridge and Paul Instrument Company was exhibiting a new oil flow meter, as shown in Fig. 43. For a long time past the need for an instrument indicating the rate of flow of oil in the lubricating systems of turbines and high-speed gears has been felt, and as a result of this need the indicator on view at the exhibition has been introduced. Other possible applications of the instrument are suggested by the makers, such, for example, as that of indicating the rate of flow of oil fuel or of the cooling water in Diesel engines. The indicator, it will be gathered, is mounted in a cock, thus making it possible to adjust the rate of flow of the liquid through the cock whilst observing the indicator, which consists of a small paddle wheel P having six blades free to rotate about the axis A. On this movable system a magnet M is fixed. Above this magnet, but in a separate sealed chamber, is another magnet N, which is free to rotate about an axis B. Attached to this same axis is an indicating disc D made of aluminium, and when the magnet N rotates

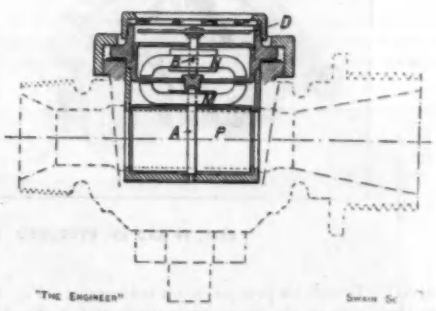



FIG. 43—CAMBRIDGE AND PAUL FLOW METER

the indicating disc moves with it. The passage of oil through the system naturally rotates the paddle P and the magnet M, which attracts the magnet N and causes it and the indicating disc to rotate at the same speed. Obviously, then, the speed of the rotating disc D gives an indication of the rate of flow of the oil, notwithstanding that the indicating disc is mounted in a chamber which is entirely distinct from that in which the oil is passing. All risk of the oil finding its way into the indicating chamber is claimed to be avoided, and the instrument is therefore particularly well suited for use where crude or hot oil is employed. Experience has shown, moreover, that the instrument may be utilised with marked advantage in connection with pipe systems in which the velocity of the oil varies over a wide range.

### COAL AND WATER METERS.

The Lea Recorder Company, Limited, of 28, Deansgate, Manchester, had a stand on which there were examples of the familiar V-notch water meters and the Lea coal meter. In connection with the latter attention was forcibly attracted to the basic principle of the apparatus, which depends on the fact that there is practically no difference in the weight of equal volumes of small coal regardless of the size of the individual pieces. Thus, by measuring the volume of coal supplied to a furnace the weight of the amount can be deduced. In applying this principle to a chain grate stoker it only becomes necessary to measure continuously the depth of the coal at the entrance to the furnace, and, seeing that the width of the fire is fixed, to register simultaneously the speed of the grate. By using an integrating mechanism similar to that adopted in the Lea V-notch recorder and con-

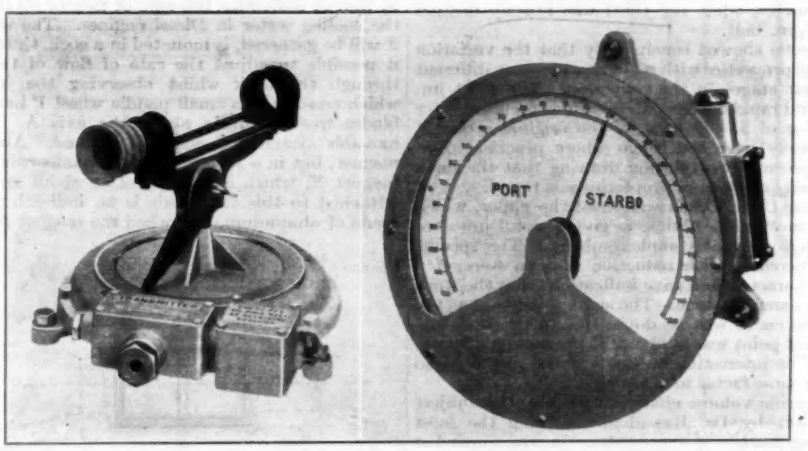
* No. III. appeared September 23rd.

necting it with the fire-door and the grate driving gear, a reading can be obtained which is a measure of the volume of coal which has passed into the fire up to the time when the reading is taken. Applying a constant, which will depend on the peculiarities of the plant, a record of the coal burnt is obtained. One of the great merits of the device, as compared with direct weighing, lies in the fact that it is not influenced by the wetness of the coal. The volume of the coal is not affected by moisture, and thus the Lea meter gives directly the weight of dry coal burnt, whereas weighings have, of course, to be corrected for moisture, an operation which is often very tedious.

Until recent times the Lea Company has guaranteed the apparatus to register within 5 per cent. of absolute accuracy, which is generally as close as direct weighing is carried if proper consideration is not given to the wetness of the coal; but in the light of the most recent tests the readings are now guaranteed to be within 2½ per cent. of real accuracy.

### Direction Indicators.

Some new instruments were exhibited by Evershed and Vignoles, Ltd. The Evershed direction of object look-out telegraph shown in Figs. 44 and 45 enables a man in a look-out station to transmit to an indicator—see Fig. 45—the bearing of an object at sea. The transmitter which is shown in Fig. 44 comprises a simple form of open sight which can be elevated or depressed and is connected to a spindle which transmits the training motion to the mechanism of the receiver shown in Fig. 45. This receiver works on the well-known Evershed principle as applied to the company's helm indicators. Between the transmitter and receiver a bell signalling circuit is provided, so as to enable the operator at the look-out position to signal to the control position and thereby notify that the transmitter is trained on to an object. A reply circuit is provided to enable the man at the control position to indicate that the information has been




FIGS. 44 AND 45—EVERSHED DIRECTION OF OBJECT INDICATOR

received. It will be perceived on referring to Fig. 45 that the scale of the receiver is even and is divided approximately into degrees, so that by suitably mounting the transmitter and receiver in relation to the fore-and-aft line of the ship the pointer of the receiver not only indicates the bearing of the object, but actually points to it. The apparatus can be operated from any direct-current supply and the indications are independent of voltage variations. As long as the circuit remains energised the transmitter and receiver readings must correspond. Another new instrument exhibited was Needham's revolution counter, which is also electrically operated. With its aid the number of revolutions of an engine or other rotating machine can be added up and indicated at any distance. At speeds up to 400 revolutions per minute the instrument indicates single revolutions, and at higher speeds it indicates every ten revolutions. In appearance the indicator resembles an ordinary mechanical speed counter. The principle, however, is new, and it is said that very little more energy is required to operate the six dials than is needed to work the unit and tens dials alone. The instrument is operated by a simple make and break transmitter connected by means of a driving chain and sprocket to the engine shaft or other piece of machinery. A two-core cable is all that is needed to connect the transmitter and counter together, and the apparatus, which can be worked from any direct-current supply, is quite independent of voltage variations.

### Motors and Motor-driven Appliances.

In addition to a good collection of alternating and direct-current motors, Pooley and Austin were exhibiting for the first time several electrical novelties, including a semi-portable chain-driven blower suitable for removing dirt and dust from the interiors of dynamos and motors, &c. The contrivance may also be used with advantage in connection with a portable forge or brazing hearth. It consists of a small rotary compressor designed to develop a low pressure and driven by a chain in a gear case from a high-speed low-power motor. As the motor is mounted directly above the compressor, the floor space required to accommodate the set is merely that needed by the compressor alone. There was also a collection of low-power or "fractional" horse-power motors of the Wilson-Wolf pattern, one of which has incorporated in it a reduction gear with a ratio of 28 to 1. There were electric bench grinders, polishers, dental lathes, and other small motor-driven appliances. A motor generator in operation on the stand converted single-phase alternating current into direct current, which was used for driving motors, &c. The single-phase motor belonging to the motor generator is one of Mr. F. Creedy's patented compensated commutator machines, which has characteristics similar to those of a slightly compounded direct-current motor. These Creedy commutator motors are also built for lift and crane service. Among the alternating-current motors exhibited is a Creedy patent multi-speed three-phase motor with its controller. The machine is capable of running at three distinct speeds and the whole of the motor winding always remains in use. The firm was also exhibiting some interesting switchgear, including a new pattern circuit breaker and an ironclad fuse board fitted with self-aligning fuses, &c. The whole of the wiring on the stand had been carried out with C.T.S. cable manufactured by the Greengate and Irwill Rubber Company, Limited.

### The Carron Company's Exhibits.

The stand of the Carron Company, of Carron, Stirlingshire, included, besides the castings and drop forgings with which the firm's name is generally associated, several classes of machinery. There were, for instance, two sets of steering gear for ships. One is a vertical steam and hand gear having cylinders 5½in. diameter with a 5in. stroke, the other is of the horizontal type for steam only, with cylinders 6in. diameter and 5in. stroke. A steam ash hoist having 4½in. diameter cylinders with 4½in. stroke was also on view. Several examples of ships' side and saloon lights might be seen, together with cargo ports and engine-room skylight flaps, the latter in cast iron or cast iron frames with steel covers. The company's ships' davit turning-out gear, which was exhibited, is made to the Board of Trade requirements. There were two haulage gears, one of which is a double-drum, worm geared main and tail rope haulage, fitted with a gear-box, motor and controller. The other was of the worm geared single endless rope type. There were also several woodworking machines on this stand.

### Air Hose Couplings.

A very handy form of coupling for compressed air hose, by Belliss and Morcom, of Ledsam-street, Birmingham, was shown on the stand of the Sheepbridge Iron and Coal Company. It was originally devised for service in the makers' own works, but proved so successful there that it has since been put upon the market. The coupling is machined out of bar steel, is blacked over to check rusting, and is of a good robust form. The two parts are held together by a sort of bayonet joint, which only requires a quarter turn to make it secure. The tightness of the joint is provided for by a long sleeve of rubber which fits into recesses in both parts of the coupling and is held into one of them by a spring steel ring. The makers say that these couplings will outlast three of the ordinary brass pattern.

### Brass and Copper Pipes.

There was a rather striking example of the tube maker's art on the stand of the Yorkshire Copper Works, Limited, Leeds, in the form of a solid-drawn copper tube only 0.008in. internal diameter and as long as 200ft. without a joint. At first sight this tube might have been taken for a piece of ordinary copper wire, so it was rigged up on the stand in connection with a cylinder of compressed oxygen, while the opposite end was immersed in water. The bubbles floating up through the water showed that there was really a passage right through the pipe. As a contrast to this fine bore tube there was an 18ft. length of 18in. copper pipe, also seamless. There were various other types of tube, including the original specimens of Bemal condenser tubes with which some tests were made over a period of sixty-four weeks to test their resistance to corrosion, as compared with the standard Admiralty mixture.

### Electric Furnaces.

The exhibits of Automatic and Electric Furnaces, Limited, comprised one of the company's standard furnaces for the correct and automatic hardening of tools, drills, dies, springs, &c.; a furnace for dealing with small articles, such as needles, fish hooks, small taps, &c.; and a standard furnace, as shown in Fig. 46, for hardening long articles, such as cam shafts, taps, reamers, broaches, gun barrels, &c. All these furnaces operate in conjunction with the Wild-Barfield indicator, which gives the exact moment when the charge reaches its critical temperature. It is claimed that all the equipments can be operated by unskilled labour, that running costs are low and maintenance expenses negligible. "With current at a penny a unit it is possible, the makers claim, to harden a ton of steel at a cost of £1 14s." The furnaces exhibited are finished in polished aluminium and have solid cast ends and doors. Indicating instruments,

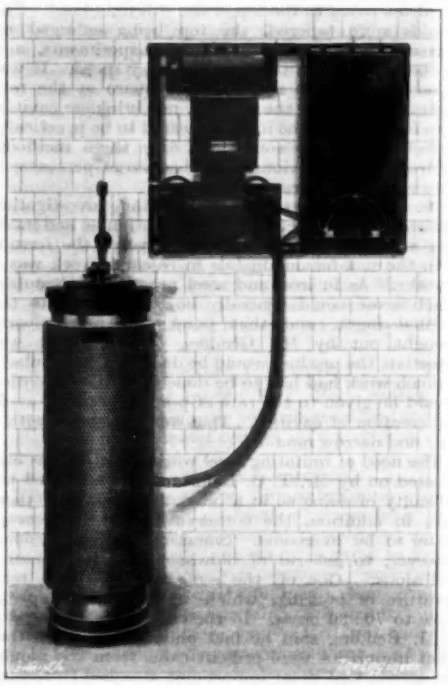
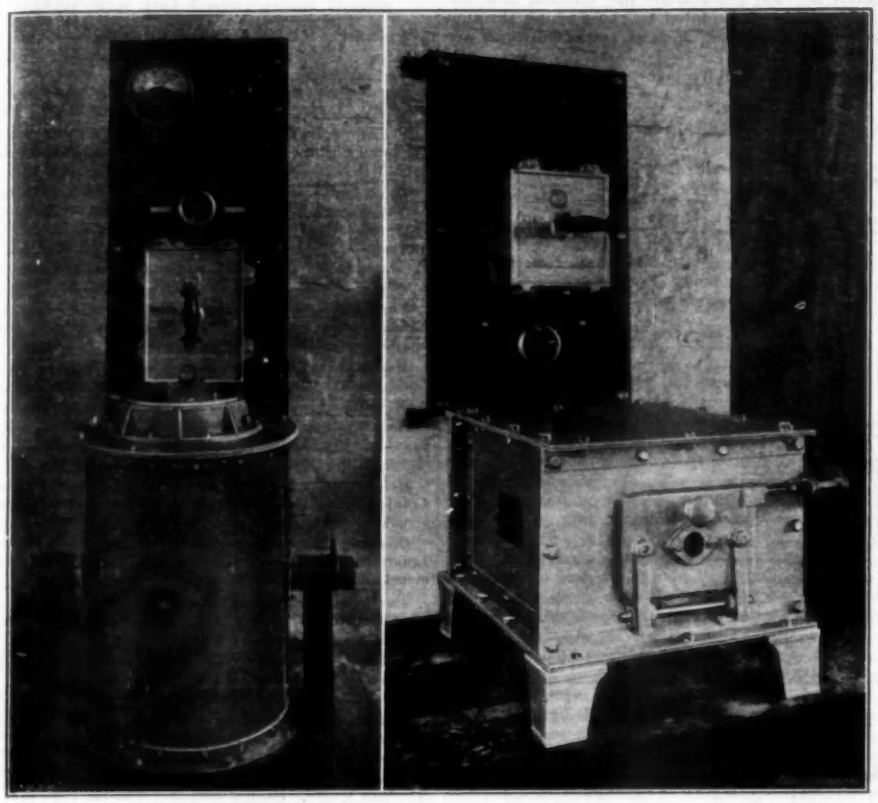


FIG. 46—AUTOMATIC ELECTRIC FURNACE

switches, fuses, &c., are mounted on a switchboard, as shown in Fig. 46, and each furnace is provided with a safety device, which, in the event of the windings attaining a dangerous temperature, cuts off the current. The general construction of these furnaces is too well known to call for a detailed description. Briefly, there is a heating chamber wound in a peculiar manner with a wire composed of a special alloy. This chamber is surrounded by another chamber which is provided with the patented device known as the pyroscopic detector, that automatically gives an indication of the exact moment at which the work should be removed from the furnace for quenching.

An excellent collection of electric resistance furnaces for melting non-ferrous metals and for the heat treatment of carbon and alloy steels was exhibited by the Leeds Electrical Construction Company, of Leeds. These so-called "Lecfur" furnaces are claimed to show marked economy over other types of furnaces which are not electrically worked, such as solid fuel, gas, or oil furnaces. An equipment for melting non-ferrous metals is shown in Fig. 47. The melting chamber, which can be tilted, is composed of special refractory material having a high thermal conductivity and a low coefficient of expansion; is capable of standing temperatures up to 1600 deg. Cent.; is chemically inert, and there is consequently no chemical reaction when melting non-ferrous metals. The heating element, which is composed of a special high-temperature alloy, is wound in intimate contact with the melting chamber, and there is an entire absence of joints. The melting chamber is supported by circular refractory discs, which are capable of withstanding high temperatures without distortion or cracking, and provision is made for expansion and contraction. The space between the refractory discs and the outer shell of the furnace body is fitted with a special kind of powder having extremely good insulating properties, and the powder

therefore acts as lagging. Attached to the top plate of the furnace is a semi-circular casing lined with refractory material to enable it to serve as a pouring spout. During the time the metal is being discharged from the furnace the spout is heated by the furnace charge, and consequently the metal does not solidify. The door of the furnace consists of a circular casting



FIGS. 47 AND 48—LECFUR ELECTRICAL FURNACES

to which refractory material is attached, and it is constructed to give a practically air-tight joint. In order to reduce the loss of heat to a minimum the furnace body is treated with aluminium paint. For use with the furnace a control panel is provided, upon which are mounted a double-pole switch and fuses of the ironclad type, also volt and ammeters and a temperature indicator, all mounted on a slate base.

Another furnace exhibited was similar to that shown in Fig. 48 and suitable for the heat treatment of carbon and alloy steels. Furnaces of this type are made with two chambers, each of which is under separate control, so that the apparatus can be used for hardening and tempering. Tilting type furnaces of this design are supplied so that when the contents of each chamber have reached the desired temperature, as indicated by the pyrometer on the control panel, the furnace can be tilted. The doors of the furnace can thus be opened by a spring latch mechanism and the contents of each furnace can be automatically discharged into the quenching tank between the supports of the furnace. With an arrangement of this sort the quenching is done in about one thirty-second of a second and all surface carbonisation of the steel is prevented. The steel is also quenched at the correct temperature. An exhibit which created a good deal of attention was one of the company's automatic electric rivet heaters. These rivet heating furnaces are also of the resistance type and can be operated on single-phase or direct-current circuits, and the rivets are heated by conduction and radiation in practically a non-oxidising atmosphere. The makers point out that as there are no products of combustion to deal with the rivets are heated under ideal metallurgical conditions. The temperature of the furnace is under perfect control. Precisely the same results can be obtained day after day. The rivets are fed into the furnace with the shank ends foremost, and they are automatically discharged at the other end at the correct temperature for riveting. The time taken for a rivet to travel through the furnace is dependent upon the speed of rotation, the size of the rivet and the ratio between the length and diameter of the rivet. When heating rivets of the same diameter, but of unequal length, the heavy rivet takes the longest time to travel through the furnace, and it therefore receives the amount of heat required to raise its temperature to the same temperature as that of the rivets composed of a smaller mass of metal. The rivet heater is therefore able to operate at practically full load with maximum efficiency, irrespective of the size of the rivets being heated.

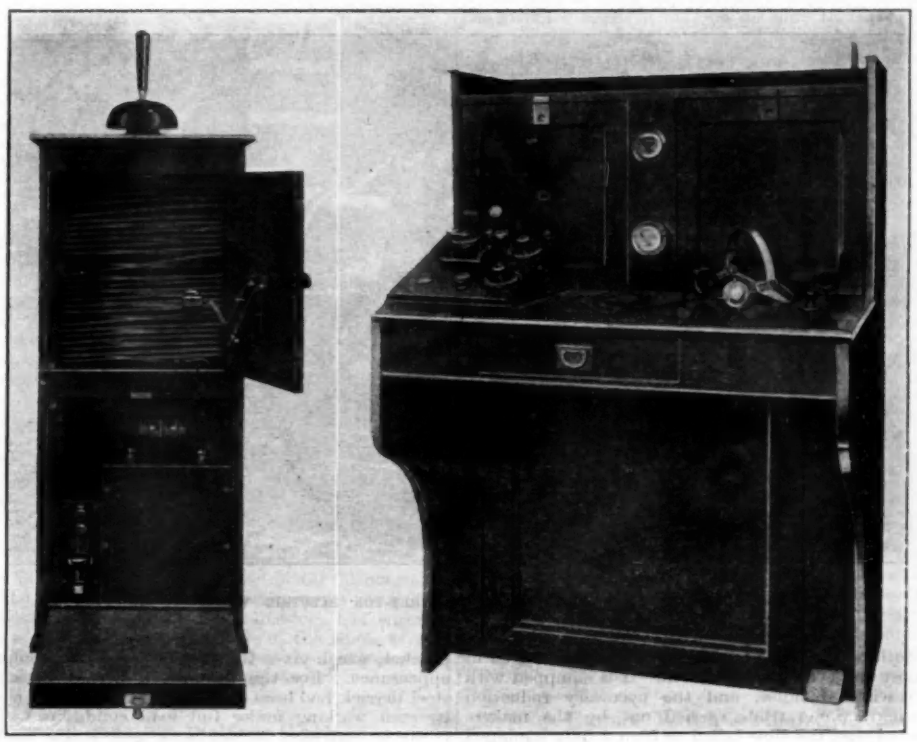
### WIRELESS TELEGRAPHY.

Visitors interested in wireless work should have inspected the exhibits of R. M. Radio, Limited. These exhibits comprised, among other things, a 1½-kilowatt emergency set, a ½-kilowatt wireless equipment fitted in a small cabin, a ¼-kilowatt equipment fitted in a cubicle, a ¼-kilowatt portable equipment, a charging board, direction finding apparatus, and the R.M.R. valve. In the design of the wireless equipments the company has aimed at simplicity, compactness, and high efficiency. As will be seen from Figs. 49 and 50, easy access can be gained to all the working parts, and condensers and other high-tension apparatus can be removed and replaced in a few minutes. The sets have been designed so that they can be operated by any telegraphist and maintained by any electrician who is not necessarily highly skilled in wireless work. The ¼-kilowatt set shown in the cubicle, Fig. 49, is contained in a cabinet very little larger than a telephone box, and the transmitter is enclosed in a cabinet 9in. by 9in. by 22in. high. The lower half of the front of this cabinet falls forward and forms a small desk, upon which messages can be written and which exposes the transmitting key and spark gap. The upper portion contains the tuning coil, and a door in front of this portion gives access to a contact clip for changing the wave length of the aerial circuit. The primary coils are of the pancake pattern and are pivoted within the aerial tuning coil so as to give a variable coupling, which is adjusted by means of a knob and locking device at the side of the cabinet. Four sockets on the primary frame enable the wave to be changed by means of a plug. Power is supplied by a small 800-cycle motor generator. A very high piercing note is therefore obtained, and the high frequency also enables the set to work with a good efficiency on small vessels which do not permit of the use of a widely spread aerial. Equipments of this class fitted to small trawlers are giving regular service over 100 miles, and others of larger sizes are working over ranges of from 150 to 200 miles.

The ½-kilowatt equipment shown in Fig. 50 can be fitted in a cabin 4ft. 6in. square. The actual size of the cabinet in which the equipment is placed is 4ft. by 3ft. by 2ft. 7in. Power is derived from a motor generator, which can be driven from the ship's lighting supply, and generates 350-period current. With the synchronous rotary discharge a note corresponding to 700 sparks per second is obtained. The primary oscillating equipment is on a shelf above the generator unit, and the unit can be drawn forward out of the cabinet without disconnecting any leads. The parts composing the oscillating and high-tension unit are so arranged that there are practically no flexible connections, and the use of concentric conductors reduces the inductance of the leads to a minimum. The aerial loading coils are in the upper cabinet and are connected with a wave-changing switch which can be shifted into four different positions. The handle controlling this switch is also coupled to the primary wave-change switch so that a single movement alters both switches simultaneously. Among other special features of the apparatus is a control pedal, which, when depressed, switches the aerial on to the transmitting apparatus and also controls the automatic switch for starting the motor generator, whilst, when the pedal is released, the aerial is switched on to the receiving gear and the motor is stopped. Hand control is also provided, but the pedal system is said to be far superior. Power and speed are controlled by field rheostats, and an ammeter giving the value of the low-tension alternating current serves as a guide to the operator when making adjustments in connection with a radiation ammeter. The normal range is 250 miles. The main features of the 1½-kilowatt equipment are the same as those of the ½-kilowatt equipment, but a complete range of instruments is mounted on a slate switchboard and the transmitter unit is enclosed in a double-walled cabinet packed with cork dust. A door is provided in the side of the cabinet so that the discharge can easily be adjusted.

### SHIPS' DAVIT GEAR.

On the stand of R. and H. Green and Silley Weir, Limited, of Blackwall, there was a model of a new type of gear for operating ships' davits. This gear, of



FIGS. 49 AND 50—QUARTER AND HALF K.W. WIRELESS SETS

which we give a drawing in Fig. 51, has been named the Uniflex, and one of its chief characteristics is the flexible nature of the connections between the various parts, which enables it to accommodate itself to any unevenness of the deck on which it is fixed. The gear is used in connection with the ordinary type of davit and is erected midway between each pair. It comprises two drums round which wire ropes are wound.

These ropes also pass round sheaves fixed on the lower part of the davits, and thus make the davits move in unison with the drums. The peculiar oscillating movement which has to be given to the davits in order to pass the boat from inboard to outboard, is provided by a very simple yet ingenious gear. The two rope drums, it will be seen, are provided with toothed quadrants, which engage with a single worm. The drums are also connected together by a link and crank pins. The quadrants are fixed on the drums in such a position that when the davits are inboard only one of the quadrants meshes with the worm. When the worm is rotated the davit driven by the quadrant in mesh begins to turn outboard. At the same time the other davit is pushed back a little by the link connecting the two drums, so that the bow of the boat may clear the first davit. The second davit is then dragged back by the link till its quadrant comes into mesh, when both davits move outwards together. Finally the first quadrant goes out of mesh and the two davits are brought square off outboard by the action of the connecting link. It will be noticed that there is always one quadrant in mesh, so that the action is always quite positive. The drive for the worm is provided by a pedestal with which it is connected by means of a shaft having flexible couplings at both ends. The pedestal can thus be arranged in almost any convenient position. It is equipped with two winch handles, and the necessary reduction gearing. Some trials carried out by the makers showed that the time taken to turn a fully equipped 28ft. lifeboat from inboard to outboard against a 7 deg. list was only 1 min. 25 sec., while a nest of three collapsible boats stowed on an island deck were handled into the water from a stowed position in 15 min., this being the time from the casting adrift of the boat lashings to the unhooking of the third boat afloat alongside the ship.

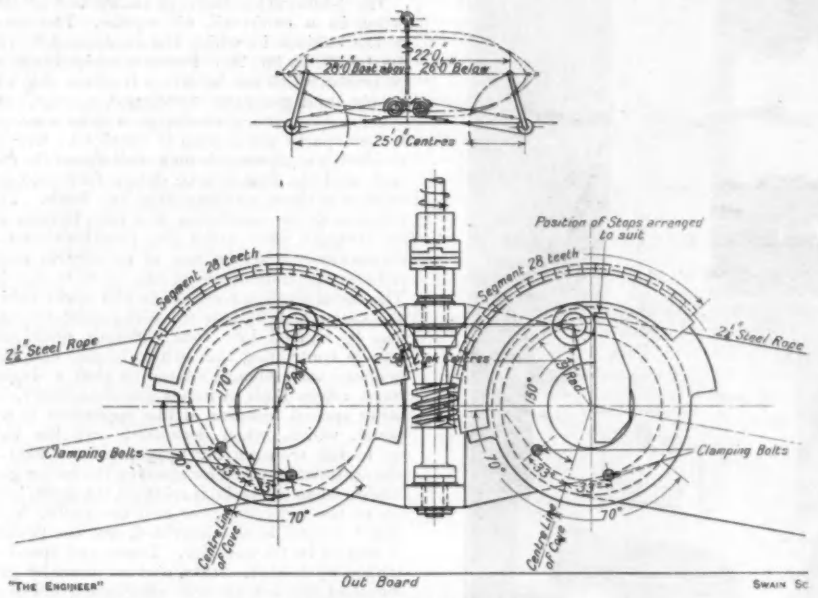



FIG. 51—UNIFLEX SHIP'S DAVIT GEAR

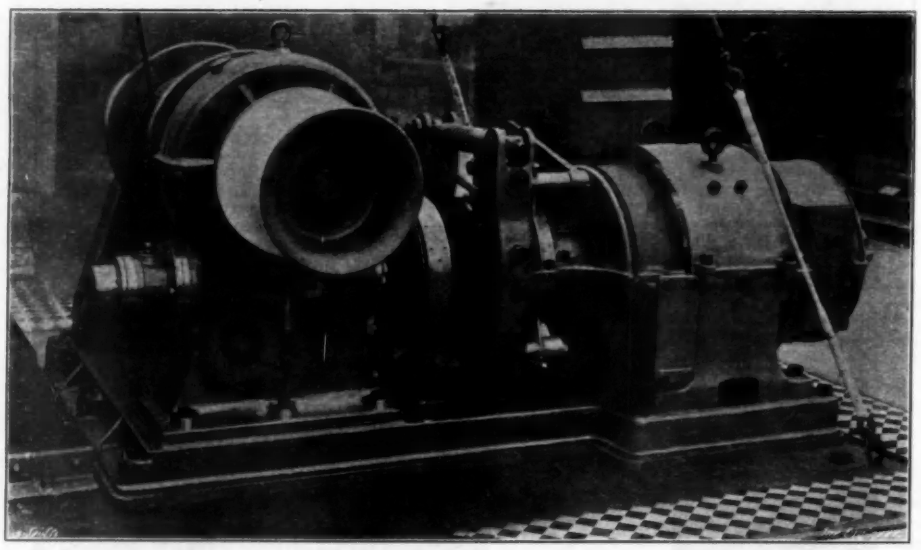


FIG. 52—METROPOLITAN-VICKERS THREE-TON ELECTRIC WINCH

### ELECTRICAL EQUIPMENTS FOR SHIPS.

A 120 kilovolt-ampère ships' auxiliary generating set designed to generate 220-volt, three-phase, 50-cycle current was exhibited by the Metropolitan-Vickers Electrical Company, Limited. As far as possible the machine is built on the same lines as the company's large turbo-alternators as installed in power stations. During the past two years no fewer than sixty-six of these sets have been built, and at the present time many are being supplied for use on oil tankers. The turbine speed of the set shown on the stand is 7500 revolutions per minute, and the alternator, which is coupled to the turbine through single reduction gearing, runs at 100 revolutions per minute.

In view of the rapidly growing demand for electrically driven deck machinery, the company has taken up the manufacture of machinery of this class, and Fig. 52 shows one of its 3-ton direct coupled winches. For driving these winches a new type of motor has been developed. The machine is of extremely rugged design and is claimed to be capable of withstanding the most severe duty to which it is likely to be subjected. It is provided with a magnetic brake, a slipping clutch to give protection in the event of the hook catching in the hatchway, and a centrifugal brake to prevent an excessive speed being reached in the event of the load driving the gear. All these devices are contained in a specially designed end bracket, which gives the motor a neat and compact appearance. For the purpose of demonstration a steel derrick had been erected so that the winch could be seen working under full load conditions. The motor is controlled by contactor gear and a master controller, which can, of course, be fixed in the most convenient operating position. Another exhibit was a single-operator welding motor generator set, which works without the use of a wasteful resistance or reactance coil, the arc being stabilised by special windings on the field magnets. The particular set exhibited has a capacity of 175 ampères and is suitable for the majority of welding operations carried out with metallic electrodes. The motor starting gear and generator control panel are mounted on iron brackets attached to the bed-plate, and the set is therefore self-contained and can easily be transported to different parts of a works. These welding sets are also made in various other sizes and for welding with metallic or carbon electrodes. They are also made for working from alternating or direct-current circuits, or the generator may be driven by a petrol engine. An excellent collection of the company's electrical domestic appliances was also on view.

## BOOKS RECEIVED.

*Die Nebenprodukten-Kokerei in Südrussland.* By L. Litinsky Leipzig: B. G. Teubner. Price 2s. 4d. 1921.

*The Steam Turbo-Alternator.* By L. C. Grant. London: Sir Isaac Pitman and Sons, Limited, Parker-street, Kingsway, W.C. 2. Price 15s. net.

*"The Electrician" Annual Tables of Electricity Supply Undertakings*, 1921. London: The *Electrician*, 8, Bouverie-street, E.C. 4. Price 10s. net.

*Artificial Light: Its Influence upon Civilisation.* By M. Luckiesh. London: University of London Press, Limited. Price 12s. 6d. net.

*Unemployment: The Cause and a Remedy.* By Arthur Kitson. London: Cecil Palmer, Oakley House, Bloomsbury-street, W.C. 1. Price 5s. net.

*Memorandum on Carbon Monoxide Poisoning in Factories.* London: His Majesty's Stationery Office, Imperial House, Kingsway, W.C. 2. Price 3d. net.

*Industrial and Power Alcohol.* By R. C. Farmer. London: Sir Isaac Pitman and Sons, Limited, Parker-street, Kingsway, W.C. 2. Price 2s. 6d. net.

*Boiler Inspection and Maintenance.* By R. Clayton. London: Sir Isaac Pitman and Sons, Limited, Parker-street, Kingsway, W.C. 2. Price 2s. 6d. net.

*Grinding Machines and their Use.* By T. R. Shaw. London: Sir Isaac Pitman and Sons, Limited, Parker-street, Kingsway, W.C. 2. Price 2s. 6d. net.

*Turbines.* By Engineer-Captain A. E. Tompkins, C.B.E. Third edition, entirely revised. London: Society for Promoting Christian Knowledge. Price 8s. net.

*Handbook of Construction Equipment: Its Cost and Use.* By Richard T. Dana. London: McGraw-Hill Book Company, 6–8, Bouverie-street, E.C. 4. Price 36s. net.

*Second and Third Reports of the Indian Railway Bridge Commission.* November, 1918, and December, 1919. Simla, India: Indian Railway Bridge Committee.

*Handbook of Practical Smithing and Forging.* By Thomas Moore. Second edition. London: E. and F. N. Spon, Limited, 57, Haymarket, S.W. 1. Price 7s. 6d. net.

*Motor Cycles and Side Cars: Construction, Management and Overhaul.* By H. Corbishley. London: Cassell and Co., Limited, La Belle Sauvage, E.C. 4. Price 1s. 6d. net.

*Factory Chemistry.* Preparatory to Courses in Metallurgy and Metallography. By W. H. Hawkes. London: Longmans, Green and Co., 39, Paternoster-row, E.C. 4. Price 4s. 6d. net.

*Heat Treatment of Soft and Medium Steels.* By Frederico Giolitti. Translated by E. E. Thum and D. G. Vernaci. London: McGraw-Hill Book Company, 6–8, Bouverie-street, E.C. 4. Price 30s. net.

## Obituary.

### KENNETH RUSHTON.

KENNETH RUSHTON, vice-president in charge of engineering, the Baldwin Locomotive Works, died on September 2nd, 1921, at the age of sixty years. He was born in Philadelphia, Pa., was educated in the city schools and Episcopal Academy, and served an apprenticeship, as machinist, under Hugo Bilgram, of Philadelphia. He entered the service of the Baldwin Locomotive Works in April, 1881, and his association with that company continued uninterruptedly until the time of his death, first as a draughtsman, and later as designer, chief mechanical engineer, and finally as vice-president. He was the inventor of many appliances used in the construction of locomotives, and was closely associated with Mr. S. M. Vauclain in the development of the four-cylinder compound that bears the name of the latter.

Mr. Rushton became a member of the American Society of Mechanical Engineers in 1920, and served on the Locomotive Boiler Sub-committee of the American Society of Mechanical Engineers' Boiler Code Committee. He was also a member of the American Society for Testing Materials.

DINNER AT OLYMPIA.—On Tuesday last a successful dinner was held at Olympia to "commemorate the successful co-operation of employers and workers as exemplified at the Shipping, Engineering and Machinery Exhibition." The chairman was Captain Riall Sankey, President of the Institution of Mechanical Engineers, and the company included many well-known engineers and labour leaders. The toast of the evening was proposed by Mr. W. A. Appleton, secretary of the General Federation of Trade Unions, and was acknowledged by Dr. Hele-Shaw. The tone of it was, as might be expected, the need of a completer co-operation between employers and employed, but Mr. Appleton appeared to wish that the workers should have a controlling voice in the industries in which they were engaged. Mr. W. Reavell proposed the toast of "Shipping and Commerce," which was acknowledged by Mr. T. Chambers, of the National Sailors' and Firemen's Union; and Mr. W. H. Patchell called upon the guests to drink the health of Mr. F. W. Bridges, organiser of the Exhibition.

# A Seven-Day Journal.

## Shipbuilding and Engineering Wages.

AT the time of writing, the outlook on the wages question in the engineering industries is exceedingly black. As many feared would be the case, the notice by employers of withdrawal of the Ministry of Munitions bonuses of 12½ per cent. on time rates and 7½ per cent. on piece work has brought a great group of industries to the verge of a strike or lock-out. It would appear that in the course of recent negotiations the question was discussed from all standpoints. A postponement of the withdrawal of the bonuses, an inquiry into the financial condition of the engineering and shipbuilding trades, and a recourse to arbitration were suggested, and, as might have been expected, rejected by representatives of employers as being beside the point. The latest phase of the dispute is the appeal to the Ministry of Labour to effect a settlement, but it may be regarded as quite unlikely that employers will grant through the Ministry better terms than they would be prepared to give to the men by direct negotiation. Employers, appalled by the high percentage of wages in the total cost of production, are convinced that these bonuses, which were given for special reasons, having no connection with the cost of living, must go, and failing agreement on the subject, their notice of withdrawal will take effect on October 12th.

## New European Railways.

CONSIDERATION is being given by French interests to the improvement of railway communication in Europe on west to east routes. The plan which appears to find most favour is of a new tunnel on the Mont Cenis route—which was opened fifty years ago this month—between Modane and Exilles, which would shorten the journey into Italy and open up a new route to Eastern Europe. It is recognised that the increase of traffic through the Mont Cenis Tunnel has made it imperative in any event to take steps to relieve the traffic situation, and it is felt that this improvement should be made part of the larger plan of providing new trans-European railway facilities. It is reported that the French Ministry of Public Works has already approved a scheme of new railway construction, which would shorten the distance between Bordeaux and Lyons. A line through Nantes–Nevers–Lyons is that which, it is believed, would best meet the views of the advocates of the Atlantic-Orient Railway. The hope of those behind this project is that goods from Central and Eastern Europe consigned to America, and imports from the United States might be sent over the new direct route for shipment at either Bordeaux or Nantes, instead of Hamburg, as under existing conditions. The new railway project is therefore one of far-reaching importance.

## Works Committees.

ADVANTAGE was taken of the representative Industrial League gathering which assembled at Mr. H. V. Roe's charming house at Leatherhead last week-end to discuss the scope and function of works committees. Mr. S. Ratcliffe, who is the chairman of the Metropolitan-Vickers Committee, dealt with the subject in the light of his own experiences. He insisted that no business could in these days be run successfully without a works committee. With regard to the constitution of the committee, it should be so framed that every man could express his ideas through it. This object could be achieved by the formation of sub-committees. It had been found that service on works committees bred in the men a greater sense of responsibility. They became familiar to some extent with the problems of management, and were able to view things from the standpoint of the employer. It made men more careful in the demands made upon employers, and gave them knowledge of the extent to which the claims of the labour side could be legitimately pressed. The impression left on the mind by the friendly interchange of opinion which took place at Leatherhead confirms that made by former gatherings. These informal, free and frank discussions are a valuable education in the ethics and economics of industry.

## South-East Lancashire Electricity Scheme.

DETAILS of the scheme for supplying electric energy to a district, which, having Manchester as its centre, extends to Wigan, Knutsford, Glossop and Rochdale, are now available. It has still to be considered by the municipal authorities concerned, and will also be the subject of a Government inquiry, but there is a general impression that it will be approved. The dominating fact in connection with it is that it is hoped to effect within five years a saving of £175,000 in generating costs, which within a period of ten years should be increased to £250,000. Many of the existing stations, owing to their comparative inefficiency, will be put out of commission, but the stations at Stockport, Ashton-under-Lyne, Bury, Bolton, Wigan, and one or two others have been marked out for extension, and, of course, the great station which the Manchester Corporation is erecting at Barton will be one of the most important centres of distribution. It is a curious fact that within this great industrial area there is no waste heat available, either in the form of gas or exhaust steam, for use in the generation of electricity, nor any water resources which cou be utilised other than for condensing purposes. It may be added that the framers of the scheme disclaim any other object than the efficient organisation of power supply and distribution within the district. It is quite the biggest thing which has been put forward, with the exception of the plans for supply in the Greater London area.

## Subsidies for Air Transport.

ON the termination of the present scheme of temporary subsidies for air services next month, the Air Ministry will give financial aid to four schemes for which official approval has been obtained. They are the existing Handley Page and Instone services between London and Paris, a new London–Paris service which is to be conducted by De Havilland monoplanes, and a daily service between London and Brussels. Special interest attaches to the monoplane service, for which the new De Havilland machines, designed to carry pilot and mechanic at over 100 miles per hour, will be available. Colonel Frank Searle, whose association with the Airco line will be fresh in memory, is the moving spirit of the monoplane service, of which he has long been a staunch advocate. Experience under daily service conditions with the new De Havillands, which are equipped with only one 450 horse-power Napier Lion motor, is being awaited with much interest in aviation circles. The London–Brussels service is admittedly experimental. Rumour suggests that a British London–Amsterdam service may be put in operation next spring as the result of the encouraging experience of the State-aided Royal Dutch air line on this route.

## Welsh Collieries Electric Scheme.

THE Powell Duffryn Coal Company has decided upon an important extension of electrical working to the various mines under its control, at an estimated expenditure of over £1,000,000. The new power-house at Bargoed—which represents the latest practice in schemes of this character—is to be extended to house plant having a capacity of 30,000 kilowatts, which will make it the largest private undertaking in the country. This station will supply current to the whole of the company's pits in the Rhymney, Aberdare and Deri Valleys and at Llantrisant, and substitute electrical for steam working for all purposes to which electricity can be applied. It is believed that a considerable reduction in working costs will be effected.

## Motor Taxation Receipts.

THE return made by the Ministry of Transport showing the amounts received from motor vehicles under the new taxation has been awaited with some curiosity. The interesting feature is the comparatively large share of the total which has been contributed by commercial vehicles, £2,639,300 out of a total of £9,276,628. The number of commercial motors now in service is 128,200. Owners of private cars, which now number 242,500, paid in taxation £3,981,000. There was an increase of nearly 3000 in the number of motor ploughs during the past three months, but road locomotives show a decline, and there has been a serious falling off in the number of motor hackneys.

## Big Disposals Board Deal.

IT is reported that the British Metal Corporation, as the result of prolonged negotiations with the Disposal and Liquidation Commission, has entered into a contract for the purchase of the whole of the brass scrap held by the Government at various centres. The sum involved is said to be £4,000,000.

## Funds for Welfare Work.

THE appeal which the Industrial Welfare Society has just issued, asking that the burden of maintaining the organisation should now be more widely shared, will, it is hoped, meet with an adequate response. That there is need to-day for strengthening the individual link in industry is freely admitted, and proof has been given that the introduction of welfare work is one of the best means of bringing this about. In the present industrial system, it is the business of the employer and his interest to deal with questions of health, safety, education, thrift, working conditions and recreation. Where these things have received attention, the relations of employers with employed have been improved, and the efficiency of the workers has been increased. Although the promotion of mutual co-operation along the lines indicated is the concern of those actively engaged in production, it is contended that a heavy obligation rests upon shareholders, bankers and professional men generally to take a part in extending the movement. The appeal now made is to these classes.

## The Big Radium Deal.

THE arrival in London this week of Professor Soddy, who is scientific adviser to the Imperial Foreign Corporation, with two grammes of radium, valued at £70,000, is a definite confirmation of the rumours of control of the Czecho-Slovakia mines by the Corporation named. The radium was enclosed in a special packing of lead, 3in. thick, and to avoid Customs troubles *en route*, Professor Soddy was accorded the temporary status of a King's Messenger, and given the loan of a Foreign Office bag. What will be done with the radium is a little uncertain. Nothing has been settled, except that it will be hired out for research and medical work. Professor Soddy hopes it may be possible to establish a research laboratory at Oxford, but rumours which have been in circulation that a decision has been reached on this point are not in accordance with the facts. The two grammes of radium, which are at present lying in a safe in London, are said to be the largest quantity which has yet been accumulated in one consignment. It is anticipated that many more shipments will be made from the famous Joachimsthal mine, but not all of it—perhaps not the bulk of it—will come to England. The agreement with the Czecho-Slovakia Government is for a period of fifteen years.

## Submarine Riveter.

MANY well-known people interested in shipbuilding attended the demonstration in London on Tuesday of the new portable tool, which it is claimed can be used under water for the cold riveting of ship plates. The tool, which weighs about 15 lb., has the appearance of a pneumatic hammer, but is fitted with a charge, the blow of which enables studs and taper pins to be driven into steel plates. In some recent experiments a diver was able to drive a bolt through a §in. steel plate in 3½ fathoms of water, and if this kind of thing can be done in regular practice, the inventor hopes it may be possible to carry out ship repairs without putting the vessel into dry dock. The tool appears to be simple to operate, and being self-contained, no external source of power is required. It is asserted by those who have had an opportunity of knowing exactly what has been done that the tool may find application in salvage work. Expert opinion is, however, divided.

## Plain Talk at Scarborough.

THE conference at Scarborough was the occasion of some expressions of opinion which probably proved disconcerting to those who prefer to shut their eyes to the things which are paralysing British industry. Mr. Andrew Dalgleish looks for a great development of the Whitley Council idea, so that not merely individual trades, but the whole country will be permeated with these Councils. Mr. Sykes, a Yorkshire representative, declined to mince matters. The thing which, he insisted, stands against the British workman is restriction of output and the associated high cost of production; and shorter hours, more leisure and improved conditions can never, he reminded the labour representatives, be secured unless the worker produced more while at work. Shorter hours without an intensification of production was only going round in a vicious circle. This is a true if trite comment on the present situation, and it brought the Scarborough Conference back to earth. The attempt to show that the capitalist is unnecessary failed, because those who desire to abolish the capitalist have no alternative scheme. After all, somebody must find the money and take risks.

## Empire Wireless Chain.

THE Leafield station, which is the English link in the Imperial chain of wireless stations, will be put in service operation to-morrow. Since it was inspected by the Postmaster-General last month, a series of tests has been carried out with what are understood to be quite satisfactory results. It is hoped that the next link in the chain, the Cairo station, will be completed before the end of the year, and meanwhile the plans for other stations will in all probability be approved and the work put in hand. The equipment for these stations will be supplied by British firms, and should provide some much-needed orders for the electrical industry.

# Some Recent Locomotive Work on the L. and N.-W. Railway.

No. I.

By E. C. POULTNEY, M.B.E., A.M.I. Mech. E., M. Am. Soc. M.E.

THESE articles describe four journeys made last summer and autumn between Euston and Crewe when I was travelling as an ordinary passenger, and two footplate runs which I have made through the courtesy of Captain H. P. M. Beames, chief mechanical engineer of the London and North-Western Railway—one between Euston and Carlisle and the second between Carlisle and Crewe. In the present article I propose to deal with the four journeys made over the Southern Division of the North-Western main line, two between Euston and Crewe and two in the opposite direction between Crewe and Euston. Two of these trips were made by the North Wales express, for the up journey the train being that booked to leave Crewe at 1.38 p.m. and due at Euston at 5.18 p.m., with two stops, one at Nuneaton at 2.56 and the second at Blisworth at 3.51 p.m. The down journey was made by the North Wales express due to leave Euston at 10.40 a.m.and due at Crewe at 2.16 p.m., running *via* Northampton, where it was heated "Precursor," having piston valves and 20½in. by 26in. cylinders.

We left Crewe at 1 h. 39 min. 50 sec., and owing to the very bad rail the engine was much troubled by slipping at starting. However, Whitmore, 10½ miles, was passed in 18 min. 40 sec. from the start, giving an average speed of 33.7 miles per hour. The first 9 miles are up hill at rates of 1 in 269, 1 in 177 and 1 in 248.

Between Whitmore and Stafford, 14 miles, the line falls all the way on easy grades, varying from 1 in 398 to 1 in 650, and the engine ran this distance in 15½ min., or at an average speed of 54.3 miles per hour. The total time from leaving Crewe to passing through Stafford Station was 34 min. 10 sec. for the 24½ miles, the speed being therefore 43.2 miles per hour. From Stafford to the stop at Nuneaton, where we arrived at 4.57, took 43 min. for the 36½ miles. The grades here are for the first 13½ miles to Tamworth mainly up and down in equal proportions, with a general tendency to fall, as Tamworth lies somewhat lower than Stafford. From Tamworth up to Nuneaton, 12 miles, the road is on rising gradients almost all the way, at 1 in 654, 1 in 439, 1 in 321, and 1 in 730 up to the station. Considering the load, the engine did well to run this length at 51 miles per hour, as immediately after passing Stafford there is the long slow to 35 miles per hour, 14½ min., and the 15 up-hill miles on to Tring required 17¾ min., giving average speeds of 54.8 and 50.7 miles per hour—a very good performance.

Having passed Tring, the remaining 31⅛ miles to London are practically all down-hill running, the ruling gradients being 1 in 335 and 1 in 339 down. We passed Tring at 4.38¾, Watford at 4.55, and Willesden at 5.8½, 14¼ miles in 16¼ min., and 12¼ in 13½ min., giving speeds of 52.2 and 53.9 miles per hour. The last 5⅜ miles between Willesden and Euston took 9½ min., equivalent to 34 miles per hour, the arrival time being 5.18 against the booked schedule of 5.15 p.m.

The train was 1 min. 50 sec. late in leaving Crewe, and 1 min. late arrving at Nuneaton, at which station a stop of 4 min. is allowed. The actual time taken was 6 min., so that we were 3 min. behind time on leaving. The arrival time at Bletchley was 3.56 against 3.51 booked, so here we were 5 min. late. After a wait of 5 min. instead of 4 min. allowed, we left for London 6 min. behind time, and on arriving at Euston at 5.18 were exactly 3 min. late. The extra time taken at Nuneaton and Bletchley was caused by the train being too long for the station platforms which made it necessary to draw up at each place. The time late in leaving Crewe and that lost at Rugby was made up by the engine's good work between Nuneaton and Blisworth, where in spite of the signal delays at Rugby, the engine ran the 34½ miles in 53 min. against 51 min. allowed, and by taking only 77 min. for the 62¾ miles from Blisworth to Euston against 80 min. allowed.

Had we not experienced the signal checks approaching Rugby, the train would easily have been on time at Bletchley instead of 5 min. late, and the 1 min. we were kept over time at Bletchley would have been made up before we arrived at Euston, for, as it was, the engine ran this distance in 3 min. less than the time allowed. The actual journey time between Crewe and London was 218 min. 10 sec., compared with 217 min., the time allowed. The running time was 207 min. 10 sec., against 209 min. booked, and the journey time and running time speeds were 43.3 and 45.8 miles per hour.

A few days later I returned to North Wales, and on arriving at Euston found the 4–4–0 type engine, John Hick, No. 752, at the head of another heavy train of eleven eight-wheeled coaches, two twelve-wheeled diners and one six-wheeled van, total 420 tons, fifty-nine axles. This engine is one of the celebrated "George the Fifth" class, having 20½in. by 26in. cylinders, and a Schmidt superheater.

The train is due to leave at 10.40 a.m. and runs to Crewe *via* Northampton, where it is timed to arrive at 12.5 and leave at 12.10 p.m. It stops at Rugby, the booked arrival and departure times being 12.38 and 12.43. We left Euston at 10.40½ a.m. and passed Willesden, 5⅜ miles, in 10 min. 40 sec., representing 30.15 miles per hour. This length includes the steep rise out of Euston at 1 in 70 and 1 in 77 for the first mile up to Chalk Farm, and the subsequent rise at 1 in 587 for just over a mile nearing Willesden Station. Passing Willesden at 10 h. 51 min. 10 sec., we were through Watford, 12⅝ miles further, in 15 min. 20 sec., and Tring, 31⅛ miles from London and 14½ from Watford, in 19 min., speeds of 47.5 and 44.7 miles per hour. The distance of 26½ miles, all up hill, from Willesden to Tring having taken 34 min. 20 sec., equivalent to 46.3 miles per hour. From Tring to Roade Station, 59⅞ miles from London, took 29½ min. for the 28½ miles, 57.6 miles per hour, Roade being passed 74½ min. after leaving Euston, giving an average speed of 48 miles per hour. From Roade to Northampton, 6 miles, took 9½ min., owing to the train having to slow down at Roade to pass over the Northampton line and to the slow run into that station. The train arrived at Northampton at 12.4½ and left at 12.9½ and arrived at Rugby at 12.37 min. 40 sec. The 9 miles to Rugby took 28 min. 10 sec. The low speed of only 19.2 miles per hour shown by these timings is due to the short distance to be run between starting at Northampton and stopping at Rugby, which was approached at a moderate speed.

Leaving Rugby at 12.44, the engine ran the 51 miles to Stafford in 61½ min. This is an easy length of road down hill for the most part, Stafford lying somewhat lower than Rugby. The speed between these points was 49.7 miles per hour. This includes, of course, the time taken in getting the train up to speed from the Rugby stop and the time taken by slowing to 35 miles per hour passing over the curve south of Stafford Station. Between Stafford and Whitmore, 14 up-hill miles, took 19 min., and the 10½ miles down to Crewe took 11½ min. only, speeds of 44.3 and 54.8 miles per hour. The arrival time at Crewe was 2.16, making the total time from London 215½ min. for the distance *via* Northampton of 160¾ miles. The actual running time was 204 min. 10 sec., so that the average speeds were 44.7 and 47.1 miles per hour. John Hick hauled the train very close to time throughout. Leaving Euston 30 sec. late, Northampton was reached 30 sec. early, and we left again 30 sec. before time according to Euston Station time. We got to Rugby 20 sec. early and were 1 min. late in leaving, and stopped in Crewe Station exactly to time at 2.16 p.m.

The work done by these two engines was, I think, exceedingly good, for although the running average speeds were not high, the loads were very heavy.

LOG NO. 1.—*Crewe and London (Euston).*

*North Wales Express.*
Fifteen coaches (64 axles), 439 tons. Engine No. 2166 Shooting Star, 4–4–0 type, two-cylinder Suptre.

| Stations. | Miles. | Miles between. | Time between min. sec. | M.P.H. |
|---|---|---|---|---|
| Crewe (dep. 1.39.50) | | | | |
| Whitmore | 10½ | 10½ | 18 40 | 33.7 |
| Stafford | 24½ | 14 | 15 30 | 54.3 |
| Nuneaton (arr. 2.57, dep. 3.3) | 61 | 36½ | 43 0 | 51.0 |
| Rugby | 75½ | 14½ | 25 0 | 34.8 |
| Blisworth (arr. 3.56, dep. 4.1) | 95½ | 19¾ | 28 0 | 42.3 |
| Roade | 98½ | 2⅞ | 5 30 | 32.4 |
| Bletchley | 111⅛ | 13⅛ | 14 30 | 54.8 |
| Tring | 126⅜ | 15 | 17 45 | 50.7 |
| Watford | 140½ | 14⅛ | 16 15 | 52.2 |
| Willesden | 152⅜ | 12⅛ | 13 30 | 53.9 |
| Euston (arr. 5.18) | 158 | 5⅝ | 9 30 | 34.0 |

*Glasgow–London Luncheon Car Express.*
Nine coaches and one van (41 axles), 339 tons. Engine No. 2268 4–6–0 type, four-cylinder Suptre.

| M.P.H. | Time between. min. sec. | Miles between. | Miles. | Stations. |
|---|---|---|---|---|
| | | | | Crewe (dep. 4.8¼) |
| 44.6 | 33 0 | 24½ | 24½ | Stafford |
| Stopped by signals, 1½ min., outside Rugby Station | | | | |
| 50.0 | 61 15 | 51 | 75½ | Rugby |
| 48.0 | 23 45 | 19 | 94½ | Northampton (arr. 6.6¼, dep. 6.13¼) |
| 30.6 | 11 45 | 6 | 109½ | Roade |
| 49.7 | 16 0 | 13½ | 113⅝ | Bletchley (arr. 6.41, dep. 6.46.50) |
| 53.4 | 32 40 | 29½ | 142⅞ | Watford |
| 63.2 | 11 30 | 12¼ | 155 | Willesden (arr. 7.31, dep. 7.32) |
| 25.8 | 12 30 | 5¼ | 160¼ | Euston (arr. 7.44½) |

LOG NO. 2.—*London (Euston) and Crewe.*

*4.45 p.m. Belfast Boat Express.*
Eleven coaches and one van, 51 axles, 375 tons. Engine No. 1407, 4–6–0 type, four-cylinder Suptre.

| Stations. | Miles. | Miles between | Time. between, min. sec. | M.P.H. |
|---|---|---|---|---|
| Euston (dep. 4.45½) | | | | |
| Willesden | 5⅜ | 5⅜ | 10 20 | 31.2 |
| Watford | 17⅝ | 12¼ | 15 30 | 47.0 |
| Tring | 31⅜ | 14¼ | 18 50 | 45.0 |
| Roade, Mile Post 60 | 60 | 28⅝ | 32 30 | 52.3 |
| Rugby | 82¼ | 22¼ | 28 40 | 47.1 |
| Stafford (arr. 7.34¼, dep. 7.41) | 133½ | 51 | 63 30 | 48.3 |
| Whitmore | 147⅞ | 14 | 19 0 | 44.3 |
| Crewe (arr. 8.14¼, 8.14 booked) | 158 | 10⅛ | 14 15 | 44.2 |

*10.40 a.m. North Wales Express.*
Thirteen coaches and one van, 59 axles, 420 tons. Engine No. 752, John Hick, 4–4–0 type, two-cylinder Suptre.

| M.P.H. | Time between min. sec. | Miles between. | Miles. | Stations. |
|---|---|---|---|---|
| | | | | Euston (dep. 10.40½) |
| 30.15 | 10 40 | 5⅜ | 5⅜ | Willesden |
| 47.5 | 15 20 | 12¼ | 17⅝ | Watford |
| 44.7 | 19 0 | 14¼ | 31⅜ | Tring |
| 57.6 | 29 30 | 28¼ | 59⅞ | Roade Station |
| 37.9 | 9 30 | 6 | 65⅞ | Northampton (arr. 12.4½, dep. 12.9½) |
| 19.2 | 28 10 | 19 | 84⅞ | Rugby (arr. 12.37.40, dep. 12.44) |
| 49.7 | 61 30 | 51 | 135¼ | Stafford |
| 44.3 | 19 0 | 14 | 149⅞ | Whitmore |
| 54.8 | 11 30 | 10½ | 160¾ | Crewe (arr. 2.16, 2.16 booked) |

timed to stop at 12.5 p.m., and stopping also at Rugby at 12.38 p.m. The other two runs are journeys made with the up Glasgow (Central) and London (Euston) luncheon car express leaving Glasgow at 10 a.m. and running to a modified schedule during the last coal strike, being due to leave Crewe at 4.5 p.m., and stopping at Northampton and Bletchley, and on the occasion under notice a stop was also made at Willesden.

The fourth trip was one made when travelling by the 4.45 p.m. ex Euston, Belfast (*via* Fleetwood) boat train, with through vehicles for Birkenhead and Barrow, and due to arrive at Crewe at 8.14, with an intermediate stop at Stafford at 7.35 p.m.

Of these journeys, the two runs made with the North Wales expresses claim first attention, as, for absolute merit, I have no hesitation in saying they equal any locomotive work that has hitherto come to my notice.

The up trip was made on the first day on which this particular train commenced running, and I travelled up to London from Llandudno Junction by it. However, my records as far as Crewe are not very complete, so I will deal only with the run from Crewe to London. On joining the train I had no idea of making any special notes as to its running, but when I saw the load of thirteen eight-wheeled coaches and two twelve-wheeled luncheon cars, sixty-four axles, totalling 439 tons behind the tender, I was at once interested to know how the locomotive would handle this very heavy train.

The engine was No. 2166, Shooting Star, a super-going over the curve on to the Trent Valley line, and there is the time taken in coming to a stand in Nuneaton Station.

Between Nuneaton, left at 3.3 p.m., and passing through Rugby, the time taken was 25 min. for the 14½ miles, giving the low speed of 34.8 miles per hour, due entirely to very severe delays caused by repeated signal checks approaching Rugby Station, which we passed through very slowly, certainly at no more than 10 miles per hour. The road beween Nuneaton and, Rugby is slightly against trains travelling to London the principal rising grades being 1 in 320 leaving Nuneaton and 1 in 365 up to Rugby.

After getting through Rugby, the engine made a good run to Blisworth, the 19¾ miles being covered in 28 min., or at an average speed of 42.3 miles per hour. The gradient for the first 4½ miles up to Kilsby Tunnel is at the rate of 1 in 370 and at 1 in 870 through the tunnel; then for the remainder of the distance to Blisworth the line generally falls at 1 in 415 and 1 in 350, and 1 in 800, ending with a three-mile rise of 1 in 2640 up to the station. We arrived at Blisworth at 3.56 and left at 4.1 p.m., and the 2⅞ miles up to Roade took 5½ min., equal to 32.4 miles per hour. Passing Roade, the first 6 miles are on falling gradients and the remaining 22¼ miles to Tring are almost all up hill on gradients of 1 in 892 to 1 in 333, the last 6 miles up to the station being a continuous rise at the latter figure. This 28¼ miles took 32¼ min., giving 52.6 miles per hour as the average speed. The 13¼ miles between Roade and Bletchley, passed at fully 60 miles per hour, took

Shooting Star maintained a running average of 45.8 miles per hour, and in the opposite direction and running *via* Northampton John Hick maintained 47.1 miles per hour. The up journey is, if anything, rather easier than the down run, mainly on account of the 30-mile climb from Euston up to Tring at the beginning of the down journey. This climb probably accounts for the fact that Shooting Star hauled a 439-ton train up to London at speeds which compare on all sections where the running was uninterrupted very favourably with those attained by John Hick with the lighter load of 420 tons. Shooting Star had a train 4.43 times her own weight, and John Hick's train was 4.24 times the weight of the engine and tender. What perhaps is, however, more interesting is that in the case of Shooting Star the total weight of the engine, tender and train was 538 tons, and for John Hick 519 tons, or respectively 14.2 and 13.57 times the weight on the coupled axles, which is 38.25 tons. In view of the performance of these two engines, it may be of interest to recall that George the Fifth, when she ran her official trial trip from Crewe to Euston, hauled a train composed of thirteen eight-wheeled coaches and a dynamometer car, the total weight of which was 359.5 tons, at an average speed of 53.75 miles per hour to Rugby, and 58.25 miles per hour between Rugby and Euston, the average journey time speed for the entire trip being 56 miles per hour. The test train was therefore 18 per cent. lighter than the train hauled by Shooting Star, which engine, however, ran 45.8 miles per hour, or almost exactly 10 miles per hour slower. These runs are particularly interesting as showing the work done by 4-4-0 type engines under ordinary working conditions.

I do not propose here to enter upon a general discussion as to the relative merits of four-coupled and six-coupled engines for express passenger service, but I have as a matter of interest tabulated in Logs Nos. 1 and 2 the performance of two four-cylinder 4–6–0 type engines of the "Claughton" class side by side with the runs made by the 4–4–0 locomotives. The records are not put forward as being strictly comparable for the reason that the 4–4–0 engines, though not working right up to capacity, were at any rate fairly near it, while it is a certainty that the large 4–6–0 engines were running well within their powers. In Log No. 1 the running of the 4–4–0 engine Shooting Star is compared with a trip made behind 4–6–0 four-cylinder engine No. 2268 on the 4.5 p.m. from Crewe to London, being the 10 a.m. ex Glasgow Central. The 4–6–0 engine was once checked by signals just after leaving Crewe, and again on nearing Stafford. She, however, passed through that station in 33 min., as against 34 min. 10 sec. taken by the 4–4–0 engine. Unfortunately, I did not get an accurate time for passing Whitmore, but the running between that station and Stafford was very similar to the work done by the 4–4–0 locomotive, so the better time was made by faster running up the bank to Whitmore. The comparison of the work done between Stafford and Rugby is rather upset by the stop made at Nuneaton, and the slows experienced approaching Rugby by the 4–4–0 engine; the latter are, however, to some extent offset by a signal stop of 1½ min. duration experienced by the 4–6–0 engine just outside Rugby Station, which reduces the actual running time taken to 59¾ min. from passing Stafford and passing through Rugby, a distance of 51 miles.

Neither of the trains, it will be noted, stopped at Rugby, where the two runs part company, as the 4–6–0 engine ran *via* Northampton. Owing to the darkness I unfortunately missed Tring Station, so have no timing between Roade and that point for the big engine, which, it will be noticed, stopped at Bletchley for 5 min. 50 sec. Bletchley is not an easy point to start from, being at the foot of an up gradient of 1 in 660, the initial part of the 15-mile climb to Tring. Blisworth, the starting place for the last part of the run to Euston in the case of the train hauled by Shooting Star, is, however, also difficult in this respect, being at the foot of an uphill climb at 1 in 320 for about 2 out of the 2¾ miles to Roade.

From passing Roade to passing Bletchley the 4–4–0 engine took 14½ min., and then to Tring the 15 miles, all uphill, were covered in 17¼ min., equivalent to speeds of 54.8 and 50.7 miles per hour. The 4–6–0 engine ran from passing Roade to the stop at Bletchley in 16 min., or at 49.7 miles per hour, and then from starting at Bletchley to passing Watford, 29¼ miles, she took 32 min. 40 sec., equal to an average speed of 53.4 miles per hour. For this section the 4–4–0 engine took 34 min. from passing Bletchley at 60 miles per hour to passing Watford. The six-coupled engine accelerated quickly from the Bletchley stop, and climbed the bank up to Tring very well. The running down the bank between Watford and Willesden was fast because the train was behind time. The 4–6–0 four-cylinder locomotives weigh 117 tons complete, so that the train weight was 2.9 times the weight of the engine, as against 4.43 times in the case of the 4–4–0 type locomotive. The total weight of the engine, tender, and train was 7.73 times the weight on the coupled axles, which for the "Claughton" class is 59 tons. In Log No. 2 the running of the 4–4–0 "George the Fifth" class locomotive, John Hick, is compared with the work done by the four-cylinder 4–6–0 engine No. 1407, hauling the 4.45 p.m. express from Euston to Crewe. The comparison holds good up to Tring, and practically so on to Roade, though here there is a slight difference because in the case of the 4.45 p.m. train I took the time passing the sixtieth mile post, whereas for John Hick the time passing Roade Station is recorded, and there is a difference of ¼ mile between these points. The 4–4–0 engine ran *via* Northampton, and also stopped at Rugby, while the 4–6–0 engine stopped only at Stafford, running *via* the main line throughout. The speeds up to Tring were very similar, and John Hick did well to average 47.5 miles per hour between Willesden and Watford, and 44.7 miles per hour on to Tring, 31¾ miles of climbing in exactly 45 min.

The time between Rugby and Stafford is interesting, the 4–6–0 engine took 63½ min. for the 51 miles from passing Rugby to stopping at Stafford, and the 4–4–0 engine from starting at Rugby to passing Stafford took only 61½ min. This is quite good, because it includes the time taken in getting the train up to speed from a start, and also the time lost in reducing speed to 35 miles per hour for the Stafford curve. The 4–6–0 engine, on the other hand, passed through Rugby station at reduced speed, and the slow for the Stafford curve did not make much, if any, difference to the time, because the train stopped at Stafford. The time between Stafford and Whitmore is exactly the same for both trains; here the 4–6–0 engine again shows that it can readily start a train and get it up to speed, for it passed Whitmore from starting at Stafford in the same time that John Hick took from passing through Stafford station at about 40 miles per hour. In considering this point, however, the relative weights for the trains compared with those of the locomotives must be kept in view. The 10½ miles to Crewe down the bank from Whitmore were run very smartly by the 4–4–0 engine; the other train was right up to time at Whitmore, so the driver did not hurry over the last part of the run. On the subject of time keeping, the 4–6–0 engine on this trip kept very close to the schedule for the entire journey. The train left Euston 20 sec. late, passed Willesden 20 sec. early, it was 10 sec. late at Watford, 1 min. at Tring, 10 sec. behind passing through the centre of Rugby station, 45 sec. early at Stafford, which station it left right on time. At Whitmore it was on time exactly, and finally stopped dead in Crewe at 8.14¼, just 15 sec. behind the booked arrival time.

For this journey the train hauled by the 4–6–0 engine was 3.2 times the weight of the locomotive complete, and the total weight of the engine, tender, and train was 8.34 times the weight available for adhesion.

All four runs indicate some good locomotive work. The distinctive features of those made behind the 4–6–0 engines were, in the case of the up journey with engine No. 2268, the good running between Bletchley and Willesden, 41¼ miles in 44 min. 10 sec., start to stop, giving an average speed of 56.3 miles per hour. The feature of the journey behind No. 1407 on the 4.45 p.m. down train was the accurate time keeping.

The performance of the four-coupled engines with their very heavy loads was meritorious, and their excellence is all the more apparent when compared with the work done by the large 4–6–0 type locomotives with proportionately much lighter loads. The train loads are the weights of the coaches only. The trains were well filled, but not crowded, with the exception of the up North Wales express, which was only very lightly loaded.

The coaching equipment was, as usual, excellent, especially on the Welsh expresses, and the travelling smooth and comfortable. In my next article I will describe my footplate runs between Euston and Carlisle and back to Crewe.

## Transmission of Electrical Energy and Tidal Power.

By T. F. WALL, D.Sc., &c.*

THE utilisation of tidal power for the generation of electricity involves a peculiar and difficult problem arising from the extremely large variation of speed of the turbines under the varying head of water.

According to the reports appearing in the Press, the proposals of the Ministry of Transport for the Severn scheme provide for an average development of 500,000 horse-power over a ten-hour day. The scheme involves the use of special direct-current generators driven by water turbines, these generators being so designed that each machine will develop about 1300 kilowatts at a constant pressure of 525 volts and at a speed varying from 300 to 500 revolutions per minute. The direct current so generated would then be supplied to rotary converters giving alternating current at 320 volts, and by means of static transformers this pressure would be raised to 60,000 volts, which would be the pressure of transmission to the Midlands. Transmission to London—a distance of 115 miles—is suggested, at a pressure of 120,000 volts.

Owing to the varying speed of the turbines, the use of alternating-current generators driven by turbines is, in the ordinary way, not practicable, since the generated E.M.F. would be of varying frequency, viz., for the speed range given above the maximum value of the frequency would be 1.66 times the minimum value. Moreover, unless elaborate automatic arrangements were made, the generated E.M.F. would also vary in magnitude more or less in proportion with the speed variation.

Such large variations of frequency and E.M.F. would be impracticable for feeding a distribution system, for the obvious reasons that motors, such as induction or synchronous motors, would have similar speed variations independently of the requirements of the consumer, and lighting and heating appliances could not be operated from a system the pressure of which widely varied.

It is clear that the proposal to generate 500,000 horse-power by means of 1300-kilowatt direct-current units and then to convert to alternating current by means of rotary converters, would involve an immense number of machines. The duplication of machines necessary owing to the generation in the first instance as direct current and then conversion to alternating current is a very serious matter, and the capital outlay for these machines alone would probably be sufficiently large to imperil the feasibility of the scheme.

The purpose of the paper is to give very briefly a preliminary outline of an alternative system obviating the difficulty of the varying speeds of the turbines. The system permits of the use of alternating-current generators driven directly from the turbines, and it is expected that an appreciable saving in capital outlay will result. The system also presents other advantageous features.

Briefly stated, the scheme involves the generation of alternating current at such a frequency that the length of the transmission line at one turbine speed—viz., the lowest—will be equal or approximately equal to one-quarter the wave length of the travelling waves of potential difference and current which will be established in the line. As the speed of the turbines increases, so will the frequency of the generated alternating current increase correspondingly, and if the excitation is constant the generated E.M.F. will also increase correspondingly. As the frequency increases the wave length decreases, so that, if at the lowest speed the length of the line is one-quarter wave length, then at double this speed the length of the line will be one-half wave length. Assuming constant current at the receiving end of the line, it is shown that, notwithstanding the rise of the generator voltage as the speed rises, the voltage at the receiver's end of the line will remain constant. The arrangements thus result in an alternating-current supply, at the receiver's end of the line, of constant voltage and variable frequency.

So long as the potential difference is constant and the frequency is high a variable frequency is not objectionable for heating and lighting apparatus. In order to obtain a supply suitable for driving motors, &c., it is proposed to obtain direct current by means of mercury arc rectifiers, and it is shown that, by such means, a constant alternating-current voltage of variable frequency, generated and transmitted in the manner already described, may be transformed to a direct-current supply of constant current and very approximately constant voltage.

The author then develops a number of equations expressing the relationships between line constants and the voltage and current vectors at the receiving and generating ends of the line respectively for quarter, half, and three-eighth wave length conditions.

### MERCURY ARC RECTIFICATION AT THE RECEIVER'S END OF THE LINE.

Assuming that the rectified load per phase is 5000 kilowatts, viz., 2500 ampères at 2000 volts, and assuming values for the reactance and resistance of the rectifier circuit and load, the following values have been calculated for the potential difference which is necessary at the secondary terminals of the transformer to which the rectifier is connected. The calculations are based on the assumption that the direct-current voltage and current are kept constant at the values given above.

| Frequency of the alternating current supplied to the rectifier. | P.D. at the secondary terminal of the transformer to which the rectifier is connected. |
|---|---|
| 800 cycles per second .. .. .. | 5900 volts |
| 400 cycles per second .. .. .. | 5500 volts |
| 600 cycles per second .. .. .. | 5650 volts |

It thus appears that for 100 per cent. variation in the frequency, viz., from 400 to 800 cycles per second, it is only necessary that the potential difference should vary by 7 per cent. in order that the rectified current and pressure should remain constant.

As already stated, for lighting and heating purposes it would not be necessary to rectify the variable frequency alternating current. If the voltage drop with increase of frequency were troublesome in the distribution system this could be compensated for by allowing the voltage at the receiver end of the line to rise by a definite percentage as the frequency increased instead of maintaining this voltage constant.

It will be observed that the proposals put forward involve the existence of a consumer's load of constant magnitude. If a large industrial area is supplied such constancy of load is not difficult to obtain, and by the establishment of electro-chemical and metallurgical industries in or near the areas supplied a practically constant load could be ensured. The extremely good load factor so obtained would ensure practically ideal conditions as regards minimum cost of supply.

* Abstract. Section G, British Association, September 13th, 1921.

IN recent years, states the *Manchester Guardian*, many Sheffield steel firms installed electric furnaces for the making of special steels, and the big outputs from them during the war helped to make good the steel deficiency. Many of the furnaces have been idle for a year, and the possibility of their being restarted appeared remote, because of the series of advances in the price of current. A few days ago, the Sheffield City Electric Supply Department reduced the price of electricity for furnaces considerably, and as a result it has been deemed expedient to restart some of the furnaces. Others are being prepared for relighting, and in a few days twelve furnaces will be in action. Combined with the cheapening of Swedish material, which has been sold in Sheffield at less than the cost of production because makers have been pressed by the Swedish banks, the restarting of the electric furnaces is a very hopeful phase of the steel trade situation.

# The Future of the Railways of India.

No. I.

THE report, Cmd. 1512, of the Committee appointed by the Secretary of State for India to inquire into the administration and working of Indian railways was issued on the 23rd inst. The Committee was appointed nearly a year ago, and its terms of reference, as announced on November 1st, were :—(1) To consider, as regards railways owned by the State, the relative advantages, financial and administrative, in the special circumstances of India, of the following methods of management : (*a*) Direct State management ; (*b*) management through a company domiciled in England and with a Board sitting in London ; (*c*) management through a company domiciled in India and with a Board sitting in India ; (*d*) management through a combination of (*b*) and (*c*) ; and advise as to the policy to be adopted as and when the existing contracts with the several railway companies can be determined. In considering the question of the East Indian Railway, the Committee will take note of the decision to remove the management to India which was arrived at when the contract with the present company was extended on the amended terms in 1919. (2) To examine the functions, status and constitution of the Railway Board, and the system of control exercised by the Government of India over the railway administration, and recommend such modifications, if any, as are necessary for the adequate disposal of the railway business of Government. (3) To consider arrangements for the financing of railways in India, and, in particular, the feasibility of the greater utilisation of private enterprise and capital in the construction of new lines. (4) To report whether the present system of control by Government of rates and fares and the machinery for deciding disputes between railways and traders are satisfactory, and, if not, to advise what modifications are desirable. (5) To make recommendations that may seem germane to the inquiry.

The Committee consisted of Sir William Acworth, who was the chairman ; Sir Henry Burt, President of the Indian Railway Board, 1914–15, and Government director of Indian railway companies, 1915–19 ; Sir Rajendra Nath Mookerjee, of Calcutta ; Sir Arthur R. Anderson, President of the Railway Board, 1919–20 ; Sir George C. Godfrey, agent of the Bengal-Nagpur Railway ; the Hon. Mr. V. S. Srinivasa Sastri, member of the Council of State ; Mr. E. H. Hiley, late general manager of the New Zealand Government Railways ; Sir Henry Ledgard, of Cawnpore, as representing European commercial interests in India ; Mr. Purshotamdas Thakurdas, of Bombay, as representing Indian commercial interests ; Mr. James Tuke, of London, a director of Barclay's Bank and of the British Linen Bank.

The appointment was the outcome of discussions originating in the question of the action to be taken in connection with the East Indian Railway, a State-owned railway managed by the East Indian Railway Company under a contract, terminable in December, 1919, with the Secretary of State. As a temporary measure, this contract was extended to the end of 1924, and it was decided that the general questions arising out of the discussions of that case should be referred to a representative committee for consideration.

### PRESENT SITUATION OF THE INDIAN RAILWAYS.

For years past, even long before the war, public opinion in India has constantly complained of the entire inadequacy of the Indian railway system to meet the needs of the country. The evidence given before the Committee in all parts of the country, and on behalf of all sections of the community, was overwhelmingly strong as to the urgent need of drastic measures of reform and reconstruction of the entire railway machine. Eleven closely printed pages of the report are devoted to examples of these complaints, and it may be remarked that they relate to railways in the north equally with those in the south, of the east as of the west ; that the tale of inability to cope with the traffic relates alike to lines managed through companies and those directly administered by the State ; and that many of the complaints date from long before the war period, though they have naturally been intensified by the abnormal conditions of recent years. Congestion at some time or at some place is a commonplace of railway management in every part of the globe. But in India for years past it has recurred each season ; it has now become normal, and will become permanent unless bold measures are taken to deal with the situation.

### FINANCE AND FINANCIAL CONTROL.

The defects just mentioned are due primarily to the failure of Government to provide the railways with adequate funds for capital expenditure on development and extensions, and even for the essential operations of renewal and repairs. They are the inevitable results of a paralysing system which has not been adapted and developed to meet the requirements of what is essentially a commercial enterprise of the first magnitude.

The total Budget receipts of the Indian Government for the year just closed, leaving out railways, were in round figures 180 crores* of rupees ; the revenue receipts of the railways were Rs. 82 crores. In other words, the railway receipts were nearly half as large as all the other items of receipts in the Budget put together.

It is the prime duty of the Indian Chancellor of the Exchequer—the Finance Member of the Council—to balance his Budget. In times of bad harvests and bad trade receipts fall off. The Finance Member is constrained to economise. He cannot reduce the Army or the civil services wholesale at short notice. Nor can he refuse to pay railway wages or to provide currently consumable stores. He can and does curtail his appropriation to railways for renewals and betterment works. And he cuts down still more drastically expenditure on new works and extensions, even although they may be in process of execution. The Mackay Committee of 1907 considered that the Government should fix periodically a standard of annual capital expenditure which, at that time, it thought might be taken at £12,500,000 (Rs. 18.75 crores), and it laid stress on the desirability of Government adopting a steady annual rate of expenditure which it might reasonably hope to maintain in times of difficulty. In practice, the Government did not see its way either to attain the modest standard recommended by the Committee, or to adhere, over a series of years, to any uniform rate. Figures are given in the present report showing the capital programme fixed for each year from 1908–9 onwards. They varied up to 1915–16 between the Rs. 13.50 crores of 1912–13 and the Rs. 18 crores of 1913–14 and 1914–15. The effect of this policy of inadequate allotments, varying irregularly up and down from year to year, would have been bad enough in any case. But it is made worse when, as not infrequently happens, the allotment is suddenly cut down during the currency of the year to which it relates, and works in progress are suspended, staffs are disbanded at a moment's notice, and materials are left lying on the ground for an indefinite period. An almost equally bad effect is produced when, late on in the year, the general financial position having unexpectedly improved, the Finance Member, with equal suddenness, lifts his hand and thus encourages the railways to spend more freely. For then, in fear of the guillotine of "lapse"—all authorised money unexpended by the end of the financial year lapses and a fresh vote is necessary for the following year—which must descend on March 31st, in eager haste the railway officials start to spend, with inadequate staff and hurriedly collected materials, the money unexpectedly thrust upon them. As an example of the evil of "lapses," a case from the Assam-Bengal is quoted, where an inadequate provisional allotment of Rs. 25 lakhs for 1921–22 was voted, with the result that rolling stock materials to the value of Rs. 43 lakhs would lie idle in England for want of about Rs. 8 lakhs for its erection in India. Another case is the Itarsi–Nagpur Railway, 238 miles in length and of importance as a new north-south connection. This line was begun in 1908, and was about half-finished when war broke out. During the war work was not entirely suspended, and it has now been resumed. For the current year a vote of Rs. 10 lakhs has been made, and if similar sums are continued the line may be finished in 1925 or 1926. It will then have cost Rs. 4¾ crores, of which Rs. 1½ crores will be for interest on the capital which lay idle whilst the line was under construction.

The report then shows the procedure adopted to obtain a vote for capital expenditure. It begins in July and ends in the Budget allotment the following March. For the current financial year, the railways asked in July, 1920, for nearly Rs. 36 crores, which was reduced in August by the Railway Board to Rs. 28 crores. The Finance Department of the Government further reduced this to Rs. 12 crores, but as some railway agents protested that they could not possibly manage with the low sums voted, the amount of nearly Rs. 18 crores was budgetted.

The Mackay Committee accepted the system of lapse as unavoidable, summing up the whole case in these words : —"The whole arrangement works back to the fundamental principle that the Government of India provides as much money in each year as it possibly can, all things considered, for expenditure on railways, and distributes that money in the way which it conceives to be most advantageous for the country as a whole." On this finding, the present report observes that if the matter were purely one of finance, the Committee would hesitate to disagree with the opinion of so authoritative a Committee. But it would observe that the Mackay Committee was appointed to report, not on Indian railways, but on Indian railway finance and administration, and that it did not include among its members anyone with experience of practical railway management.

The present Committee does not think that the Indian railways can be modernised, improved and enlarged so as to give to India the service of which it is in crying need at the moment, nor that the railways can yield to the Indian public the financial return which it is entitled to expect from so valuable a property until the whole financial methods are radically reformed. And the essence of this reform is contained in two things :—(1) The complete separation of the Railway Budget from the general Budget of the country, and its reconstruction in a form which frees a great commercial business from the trammels of a system which assumes that the concern goes out of business on each March 31st and recommences *de novo* on April 1st ; and (2) the emancipation of the railway management from the control of the Finance Department. The primary function of any such Department is to reduce to a minimum expenditure in order to keep at the minimum the corresponding taxation. Its officials are not qualified either by training or experience to judge the essentially commercial and technical question where and when the circumstances of a railway undertaking justify bold expenditure of large sums, having regard not merely to the actual conditions of the physical machine at the moment, but to the prospects of development and the requirements of the future.

Witnesses from all parts of India have agreed in recognising that rates and fares should be increased, and saying that they will be ready to pay the increases, provided a reasonably efficient service is given in return.

### THE CONSTITUTION, STATUS AND FUNCTIONS OF THE CONTROLLING AUTHORITY.

The controlling authority must be single and self-contained. The recommendations which follow are based on the assumption that the railway authority is master in its own house, not sharing its responsibility with any other Department, but answerable directly through its own chief to the Governor-General in Council and the Legislative Assembly.

Briefly, the administrative position is this :—The ultimate authority for the Government of India rests with the Secretary of State, as representing the House of Commons. He delegates to the Governor-General in Council—commonly spoken of as the Government of India—certain powers, reserving others. The Government of India, in turn, delegates some, or some portion, of these powers to the Railway Board. Within the scope of these powers, the Railway Board is free to act, subject always to the Finance Department.

Railways are under that Member of the Council who deals with commerce and who cannot be in constant touch with the work of the Railway Board. The Committee is convinced that the Indian railways will never be able to give a satisfactory account of themselves, to earn the revenue which they should earn, and to render the public the service which they ought to render, until they are represented in the Viceroy's Council by a Member who is fully in touch with their daily work. It is therefore recommended that there be a Member of Council in charge of Communications, whose portfolio should comprise railways, ports, inland navigation, road transport—so far as it is under the control of the Government of India—and posts and telegraphs.

At several points in the report attention is called to the constant interference of the Government in the details of railway executive management. The whole of this interference falls upon the Railway Board. The Committee was informed that 71,000 communications were issued from or were received by the Board's office last year ; a large proportion of these have to be brought before, if not the full Board, at least one of the members. The railways have to obtain from the Board sanction in matters of a minor character, whilst the Board has to apply, not merely to the Government of India on the spot, but to the Secretary of State, 6000 miles away, for sanction in matters of apparently quite trifling importance. It seems to the Committee that, in consequence of the regulations under which the Railway Board acts, the members spend a large part of their time, on the one hand, in doing the work of their subordinates which these subordinates ought to do for themselves ; and, on the other hand, in obtaining from their superiors permission to do the things which they are fully competent and ought to be permitted to do for themselves.

It is recommended that under the proposed Member of Council for Communications there be a Chief Commissioner of Railways and Ports, and under him a Commissioner for Finance and three Divisional Commissioners. The present eight engineering inspectors should be reduced to three—one for each division. These and other proposed changes and additions in the headquarters establishments will involve some additional expenditure, possibly something like £25,000 or £30,000 a year. The expenditure is necessary and is in the interest of true economy.

Witness after witness, representing Indian opinion, has complained that the Indians have no voice in the management of their own railways. A Central Advisory Council and Local Advisory Councils are therefore recommended.

### MISCELLANEOUS COGNATE QUESTIONS.

One of these miscellaneous questions relates to railways owned by the various states, which must not be confused with State-owned railways. The purport of the remarks as to these lines is that their direction too often follows the frontier of the state concerned, and not the route which physical and commercial geography would naturally suggest. The Committee thinks that when the proposed Railway Commission finds itself in financial circumstances which make it possible to take up long-postponed objects of extension and new construction, the relation between the railways belonging to the Government of India and the railways belonging to the Indian states will have to be reviewed from the broad standpoint indicated.

Branch and feeder lines are built under a State guarantee. The financial terms usual before the war are now, naturally, quite inadequate, and will have to be revised if the system is to continue. The branch line company is usually a fifth wheel in the coach. It implies in some cases a separate construction staff ; it always implies a separate board of directors and separate accounts. In cases where the branch is worked by a main line company and its directors feel that the management is unsatisfactory, they can only make representations to the main line administration, and, in the last resort, appeal to the Railway Board. This does not make for harmony.

The number of companies should be reduced by amalgamation. As it seems clear though that branch lines will never be made if left to the main line companies to build, private enterprise should be encouraged.

Of the 36,735 miles of railway in India, only 17,990 miles, or less than one-half, are of the Indian "standard," or 5ft. 6in. gauge. There are over 15,000 miles of metre gauge, nearly 3000 miles of 2ft. 6in. gauge, and over 600 miles of 2ft. gauge. A study of the gauge problem is recommended—Sir Henry Burt dissenting.

There are roughly 700,000 Indians and only 7000 Europeans engaged on the railways of India, a proportion of just 1 per cent., but the 7000 are like a thin film of oil on the top of a glass of water, resting upon but hardly mixing with the 700,000 below. None of the highest posts are occupied by Indians ; very few even of the higher. The employment of Indians in the higher posts is growing, but the process should be accelerated. The Committee thinks the Government of India might consider the propriety of establishing a minimum percentage of Indians to be reached within a fixed period. The minimum would have to be higher, or else the period shorter, in the traffic than in the engineering and locomotive departments.

The Committee is also of opinion that the system of selection and training of the young men required as probationers in the traffic department on Indian railways needs reconsideration. The whole subject is one which, in its view, should be in the special charge of the Railway Commission, and substantial grants of money should be made for the purpose of developing such instruction.

### MANAGEMENT AND FINANCE.

On the question of management, the Committee is divided in its recommendations. Five favour State management and five favour company management. These recommendations will be summarised in a later issue.

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THE Kyoto municipality, Japan, is planning a large electric power station, with steam plant, at an estimated cost of 4,300,000 yen, to be completed within three years. Two generators, each of 5000-kilowatt capacity, will be installed.

* One hundred thousand rupees, written Rs. 1,00,000, equals 1 lakh ; ten million rupees, written Rs. 1,00,00,000, equals 100 lakhs equals 1 crore.

## Railway Matters.

A COLLISION occurred at Dawlish, Great Western Railway, on Thursday, the 22nd instant. The 10.25 a.m. express from Plymouth to Paddington collided with a goods train which, according to Press advices, was being shunted from the up to the down line to allow the express to pass.

THE companies which are in the Eastern, North-Eastern and East Scottish group have issued a booklet for distribution among traders and the public showing the facilities this group will be able to afford. It is stated that these companies, in anticipation of formal amalgamation, are bending their energies to give the public the benefit of the co-ordination grouping will furnish.

THE restoration of day excursion tickets, even at a single fare for the double journey, has led to considerable reductions in the prices for char-à-banc trips. One of the most remarkable changes is reported from Rhyl, where 19s. 6d. used to be charged for the journey to Snowdon and back. The introduction of a railway fare of 9s. 3d. has led to the fare by motor being reduced to 10s. 6d.

ALL the railway companies are, from October 1st, reducing their parcel rates in order to place their rates on a level with the parcels post. The Southern companies are going further in order to compete with parcels-carrying companies and to discourage large firms from making their own deliveries. The present rates, it may be remembered, were put into force during the war as a restraint on the sending of small parcels.

ON Thursday and Friday, the 15th and 16th instant' representatives of the Scottish railway companies met the men's leaders. It is understood that from the companies' side a series of proposals was submitted which, if accepted by the unions, will have the effect of modifying to a considerable extent the provisions of the National Agreement accepted by the companies and unions in August, 1919. The companies' proposals, which are far-reaching in their scope, affect wages, salaries, overtime payments, Sunday duty, and holidays of the staffs. The union representatives have taken note of the proposals and will submit them to the members of their respective organisations.

PERHAPS the outstanding feature of the October train alterations is the introduction of a through train between Aberdeen and Penzance. This is an enterprise of the eastern group of companies—the North British, North-Eastern and Great Central being responsible as between Aberdeen and Banbury. At the latter point the Great Western will take charge and convey the through coaches to Swindon, where they will be attached to the 10 p.m. from Paddington and be due at Penzance at 7.40 a.m. As the train will leave Aberdeen at 9.45 a.m., the journey will be one of 22 hours, the longest continuous journey in this country. The Euston-Thurso Naval Special during the war took 21½ hours.

FOR the last ten years the American railroads have been engaged on a study of the rail question in order to meet the growing number of failures. Last year the American Railway Engineering Association adopted a new specification which imposed a number of new restrictions on manufacturers, designed to eliminate defects causing failures. The manufacturers are, however, unitedly opposed to this specification, either refusing directly to accept orders for rails to be rolled under it, or placing such a high premium on them as to accomplish the same purpose, basing their position largely on the contention that the roads have not proved the necessity for these restrictions or the plea that conformity with them will eliminate the present defects.

IN reply to a statement recently published to the effect that large quantities of freshly caught whiting are daily being given away or thrown overboard at Plymouth because the railway charges far exceed the prices obtainable at Billingsgate, the Great Western Railway Company states that the charge for the conveyance of fish from Plymouth to London, a distance of 226½ miles, is only 4s. 5d. per cwt., or less than ½d. per pound, a charge which also includes the delivery of the fish into Billingsgate Market. "Whatever may be the prices obtainable at the market," the company adds, "the retail charges for whiting in London to-day vary from 6d. to 10d. per pound, according to the district, therefore the railway charge does not in any way affect the situation."

ACCORDING to the Board of Trade returns, the value of the railway material exported during the seven months ended July 31st was as follows, the corresponding figures for 1920 and 1919 being added in brackets:—Locomotives, £4,424,109 (£2,977,655, £517,331); rails, £1,828,962 (£1,387,030, £1,055,403); carriages, £899,818 (£851,270, £249,882); wagons, £3,425,245 (£3,195,889, £646,913); wheels and axles, £1,203,229 (£1,131,533, £301,889); tires and axles, £913,598 (£764,791, £525,380); chairs and metal sleepers, £761,963 (£448,851, £145,381); miscellaneous permanent way, £1,660,199 (£1,394,349, £475,737); total permanent way, £6,520,520 (£5,180,745, £1,700,060). The weight of the rails exported was 82,900 tons (73,746 tons, 65,621 tons), and of the chairs and metal sleepers 30,328 tons (21,021 tons, 8938 tons). During July, locomotives to the value of £545,105 were sent to South Africa, and of £292,277 to India.

IT is well known that for a considerable period there have been complaints as to the congestion in the Metropolitan District trains going eastbound from the City. In reply to a recent question, Mr. Neal said that the improvement of services between the points named—Aldgate and Barking—was a matter for the District and Midland railway companies with whom the Minister of Transport had been in constant communication. The main difficulty arises from the limited capacity of a portion of the line, to remedy which would entail considerable expenditure which the companies concerned are at present not in a position to face. To understand the position we would say that the line east of Bow-road is part of the London, Tilbury and Southend Railway, now the property of the Midland Company. The new coaches of the District Railway have an overall width of 9ft. $6^{15}/_{16}$in., which is in excess of the Midland gauge limit for its section. Hence the Midland refuses to allow the coaches to travel beyond Bow-road. The District argues that there is sufficient clearance, but the Midland is master of the situation, and thus the congestion is unrelieved.

## Notes and Memoranda.

A NEW works is being erected in British Columbia for the production of wood alcohol, charcoal, and acetate of lime. The present plant will be able to treat 10½ cords of alder daily, but refining machinery is being installed sufficient to handle the output of three times this amount.

IN a paper read before a recent meeting of the American Iron and Steel Electrical Engineers, and American Institute of Electrical Engineers, Pittsburg, Mr. B. G. Lamme discussed the growing tendency to adopt 60-cycle in preference to 25-cycle current in connection with the electrical operation of steel mills. He pointed out that high speed resulted in lower first cost of a machine, but low speed was most in demand in steel mill work. In the development of induction motors the tendency was towards higher speeds, and 60 cycles presented material advantages. For many kinds of service, gearing was now used where direct connection, a few years ago, was considered the only permissible arrangement.

WE hear that a scientific test house, the first of its kind is Australia, has been established in Sydney by Mr. H. H. Scotland, B.Sc. The programme laid down by the founder of this new establishment embraces general scientific investigation, such as ascertainment of the calorific values of fuels, testing of steam and internal combustion engines, calibration of electrical instruments, and the heat treatment of steel. Furnaces are being put in for the treatment of high-speed steel, for case-hardening and the hardening and tempering of steels generally for traders. Later on it is intended to provide for special equipment for the mechanical testing of steel and other methods, also the testing of electrical machinery.

AT the recent annual meeting of the Society of German Engineers, Director Otto H. Hartman read a paper on the utilisation of high-pressure steam up to 60 atmospheres (say, 800 lb. per square inch) pressure, for power production and heat saving. Results proved, he said, that all the objections raised against the use of superheated steam of such high pressure were unfounded. From the point of view of heat economy, steam engines up to 1500 horse-power supplied with steam at a pressure of above 30 atmospheres proved far superior to the best steam engines operated with ordinary superheated steam. Such engines, the author stated, have given efficiency results equal to those obtained with gas engines.

A DEMONSTRATION was given at Caxton Hall on Wednesday last of a novel method of attaching patches over holes in ship's plating. The patch, having been prepared and drilled, is placed over the hole and screwed studs are then literally shot into the plate behind. Nuts are screwed on to the studs to secure the patch. The studs have a point similar to that of a projectile and are driven right through the plate by a charge of explosive, from a kind of gun which is held up to the plate by hand. The plate grips the studs so firmly that they will part rather than pull out. At the demonstration, which was given by the Temple Cox Research Company, of Dacre House, Dean Farrar-street, Westminster, several ¼in. studs were fixed in ⅜in. steel plates, both above and below water.

IN discussing the collapse of a large reinforced concrete building in course of construction, the *Engineering News Record* comments as follows on the progressive deflection of the girders under a fixed load:—"This is a most unusual phenomenon, and one on which more data should be given. The progressive deflection of five or six months' old concrete beams has been largely a matter of laboratory investigation. Some experimenters have noted this deformation under load, but the observation of such conditions in actual structures has been most rare and has never, we believe, been given as a cause of failure. The dangerous possibilities of plastic deformation have been much discussed in academic fashion. Here is an opportunity for practical analysis and no data which would help such an analysis should be withheld."

AT the Kern River No. 3 power plant of the Southern California Edison Company, there are two 25,000 horse-power Francis turbines working under a static head of 810ft. As it is sometimes necessary to deliver 60-cycle current and at others 50-cycle current, the turbines are provided with changeable runners. One of the runners is designed to operate with highest efficiency at 500 revolutions per minute, which gives 50-cycle current, and the other to operate at 600 revolutions per minute, giving 60-cycle current. In order to make practicable an arrangement of this sort, the turbine was designed with a view to facilitating a quick change of runners. The entire internal part of either turbine is removable from below, which obviates the necessity for disturbing either rotor or stator of the generator when dismantling the hydraulic part of the unit. During the test on the plant, the runners were changed in twenty hours from the time the unit was taken off the line until it was in service again at different frequency.

IN a note contributed to the *Journal* of the Institute of Marine Engineers, Mr. R. Kingdom gives an account of the troubles experienced with some motor launches at Mudros repair base. The launches were 100ft. long, constructed of wood and fitted with twin sets of six-cylinder petrol engines of 220 horse-power each. Considerable trouble was caused through the propeller shafts breaking. These shafts were 29ft. long of 2¼in. steel, and were bolted direct to the crank shaft, which had a roller bearing thrust between the coupling and end main bearing. When the first fractures occurred, time did not permit of any careful alignment of the shafts, and spare shafts were fitted, and the boats sent away at once. At the first opportunity, however, a boat with a defective shaft was taken in hand. Battens were first set up on deck while the boat was afloat—as the decks were strained all shapes—the boat was then placed on the slip and set up until the floating alignment of deck was obtained. In the first boat dealt with, it was necessary to raise the engines 4½in. to get a true alignment with the stern gland and "A" bracket. The supply of spare shafts was exhausted, and some boats had to be fitted with shafts made of two and three odd pieces joined by muff couplings, but in no case did a shaft break on a boat after the engines had been raised.

## Miscellanea.

THE contract for the construction of a bridge over the Yellow River, China, on the line of the Pekin-Hankow Railway, has just been awarded a Belgian concern, whose tender was 10,500,000 dols.

AS the distance of audibility of sound is of great scientific importance in questions relating to the structure of the atmosphere, the Director of the Meteorological Office, Air Ministry, is asking for any information from those who heard the sound of the Oppau explosion.

THE parliamentary group of the Bulgarian agriculturists' party has elected an economic commission for the purpose of examining certain question of great importance to the country. Among the questions to be considered by the commission are the electrification of the railways, the manufacture of briquettes from Pernik coal, the erection of a State silk piece goods manufactory, and the encouragement of the cultivation of hemp.

THE State road between Osaka and Kobe in Japan is to be reconstructed on modern lines. It will be 72ft. wide and will carry the new track of the Hanshin Electric Railway Company. At present there are three railways between Osaka and Kobe—the Hanshin Electric, the Government Railway, and the Hanshin Kyuko—but they are insufficient to cope with the increasing traffic between the two cities. The completion of the new line will further add to the development of the district between Osaka and Kobe.

CONSEQUENT on the suspension of payment of the Banque Industrielle de Chine, which held the French shares, the board of directors of the Peking Tramway Company has petitioned the Government to cancel the Sino-French agreement in connection with the formation of the organisation, so that it may be converted into a purely Chinese enterprise. The Ministry of Finance has appropriated 500,000 dollars for Government shares, so as to enable the work to continue without interruption. The Ministry of Foreign Affairs is negotiating with the French authorities to secure the cancellation of the agreement.

PETROLEUM shale has for many years been worked in Australia, and it is known that the strata in which petroleum is found exist in large quantities. Prospecting for oil is being vigorously conducted throughout the Commonwealth in consequence of the £50,000 reward for payable deposits offered by the Federal Government. The search in each State promises to be thorough. A State Act of Western Australia, in addition, provides for the issue of licences to prospectors for oil with liberal rewards for discoveries in payable quantities. The quantity of oil to be recovered before the Federal Government's reward can be claimed is stated to be 50,000 gallons.

THE long-contemplated fusion of the Skoda Works and the United Machinery Company, Limited, formerly Skoda, Ruston, Bromovsky and Ringhoffer, is now reported to have taken place. At a general meeting of the two companies it was decided that the Skoda Works should take over the whole of the works of the United Machinery Company, Limited, the shareholders in the latter to receive shares of equal value in the Skoda Company. This agreement gives formal effect to an arrangement that has already existed for some time. The new amalgamation is of considerable importance, since the share capital of the Skoda Works amounts to 144 million kronen, while that of the United Machinery Company, Limited, is 50 million kronen.

WE are informed that Sir W. G. Armstrong, Whitworth and Co., Limited, have obtained the contract for the conversion of the Cunard liner Berengaria from coal to oil fuel burning. This great vessel—perhaps better known as the Hamburg-Amerika Imperator—is the third largest ship in the world, being 882½ft. long by 98½ft. beam, with 57,000 tons displacement. The four propellers are driven by steam turbines which develop over 76,000 horse-power. The contract, which will probably take six months to complete, will be carried out at the Armstrong Yard, Newcastle-upon-Tyne, where the Cunard liner Aquitania, which has been so successful as an oil fuel burning ship was recently converted to oil fuel and reconditioned.

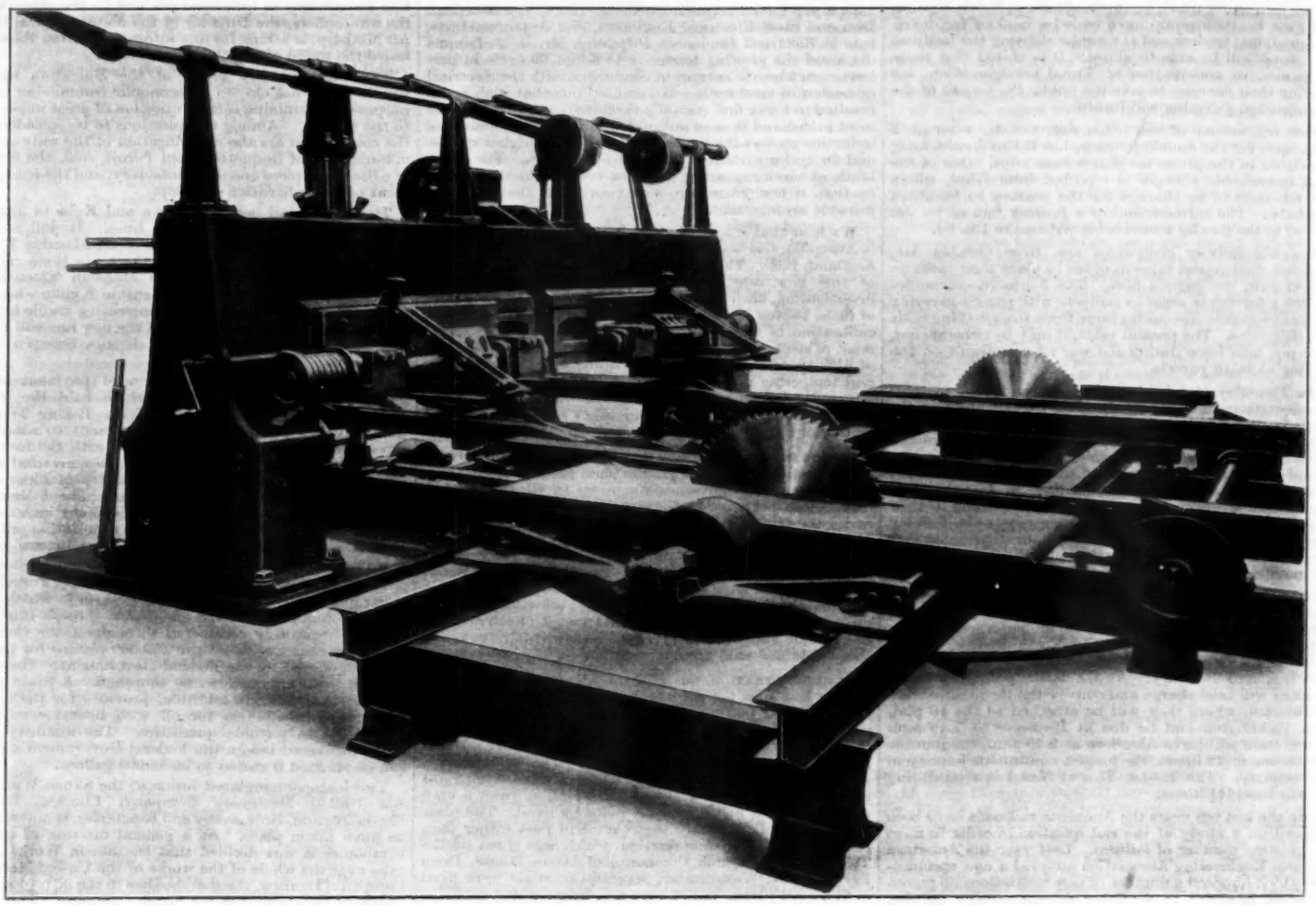
LAST Saturday, M. Le Trocquer, French Minister of Public Works, officially handed over the extensive wharves, warehouses and dockside plant of Basseno, the port on the Garonne opposite Bordeaux, to the Bordeaux Chamber of Commerce. Basseno was the port used by the American Army during the war, and the whole of the modern equipment was sold after the Armistice to the French State with the rest of the American works and stocks in France. The Bordeaux Chamber of Commerce has for some time been negotiating the purchase of the Basseno docks from the State, and the price finally agreed upon was 10,895,000f. The addition of Basseno to the port of Bordeaux will greatly extend the accommodation both for passenger and goods traffic, and the excellent railway communication with the main lines of France should avoid any congestion of the quays, however much traffic may increase with the growing importance of Bordeaux as an Atlantic seaport.

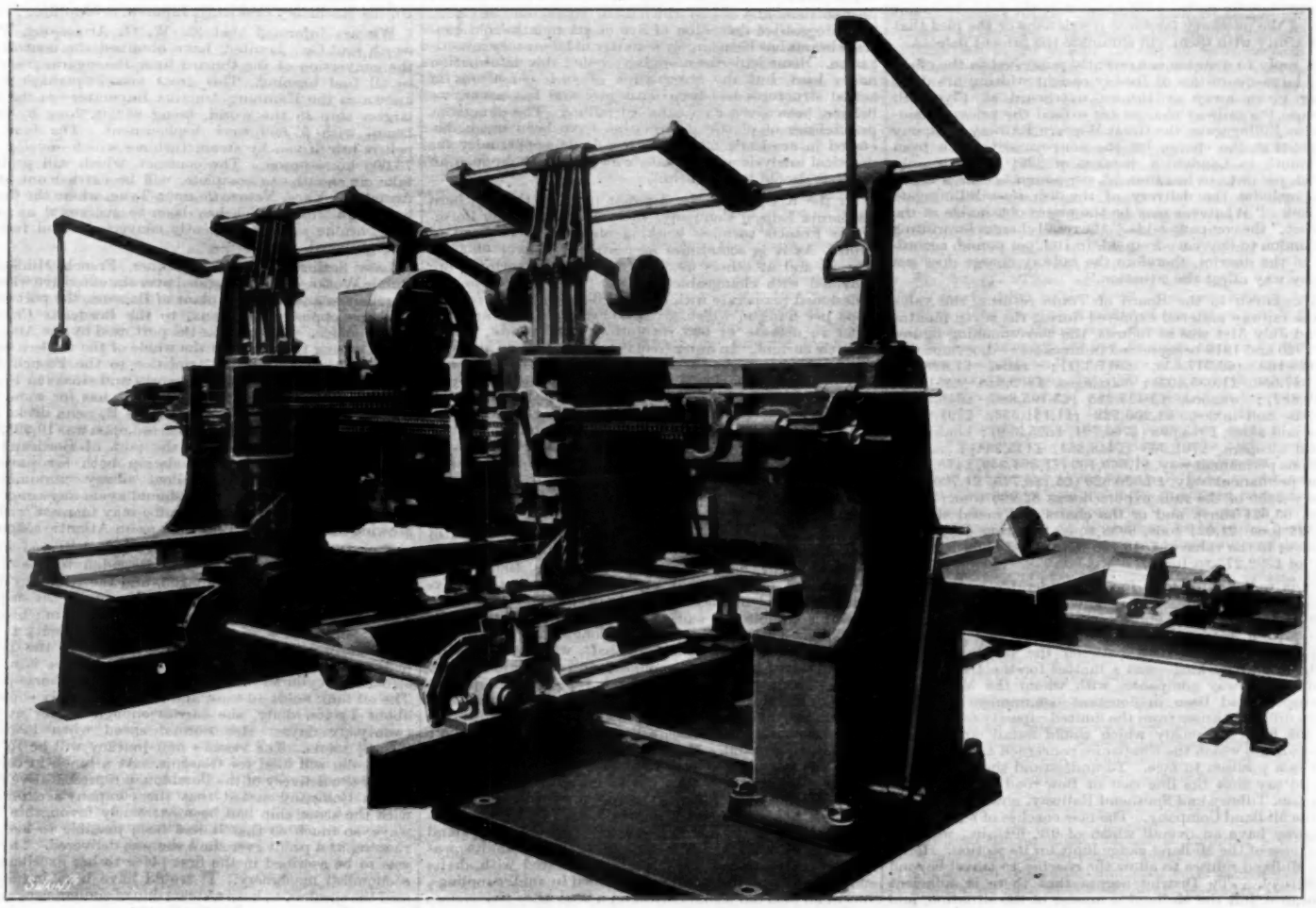
THE Danish firm Koege Vaerft has delivered a new reinforced concrete motor ship Poseidon to the Triton Shipping Company, Copenhagen, and the trial trip in the Sund proved, it is reported, in all respects satisfactory. The dimensions of the vessel are:—Length, 60 m.; breadth, 10 m.; draught, 4.75 m. Her carrying capacity is 1300 tons deadweight, and she is a sister ship to the Triton, delivered in October last. The motive power is a four-stroke six-cylinder Diesel engine of 400 horse-power. The oil tank holds 40 tons, and as the boat only consumes about 1½ ton daily, she carries enough oil for at least twenty-six days. Her normal speed when loaded is 8 to 8½ knots. The vessel's first journey will be to Kiel, where she will load for Glasgow. At a lunch in celebration of the delivery of the Poseidon, a representative of the Triton Company stated that the company's experience with the sister ship had been extremely favourable in all ways, so much so that it had been possible to keep her running at a profit ever since she was delivered. This fact was to be ascribed in the first place to her excellent and economical machinery. It would have been impossible, said the speaker, to keep a steamship of similar size running during the same period at the freight rates obtainable.

# SLEEPER ADZING, BORING AND CROSS-CUTTING MACHINE

THOMAS ROBINSON AND SON, LIMITED, ROCHDALE, ENGINEERS

(*For description see page 353*)





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# THE ENGINEER.

*SEPTEMBER* 30, 1921.


### The Acworth Report on Indian Railways.

THE Committee, presided over by Sir William Acworth, which has been inquiring into Indian railways, held an informal meeting in Calcutta on December 17th last, but its composition was not completed until January 3rd. It heard its last witnesses in India on March 12th, and the last in London on June 10th, and fifteen weeks later the report was published. The greater part is summarised on another page, and the remainder will appear in a later issue. What was intended to be an inquiry into the future of the East Indian, Great Indian Peninsula, the Burma and other company-operated State-owned railways when their contracts expire, developed into a strong indictment of the Indian Government for its neglect of the railways in India. Right in the forefront of the report it is said that the evidence "was overwhelmingly strong as to the urgent need of drastic measures of reform and reconstruction of the entire railway machine" and that "the failure to meet the needs of the country is not temporary and not confined to certain places or certain periods, but universal and permanent." Whilst it will be clear on reading our summary that the indictment is lodged against the Indian Government alone, it may be desirable to emphasise here that no part of the blame is attributable to the Railway Board. That body, as well as the Indian railways, Indian traders and the Indian public, deserves considerable sympathy. It is out of the question to give here many examples that point to the necessity for reform; they are too numerous. A prime factor undoubtedly is that the railways are included in the general Budget, and instead of the profits from them being returned to them for expenditure on new works, additional equipment and betterments, they have gone to assist the general taxation. So much were the railways starved during the war period that the net profits mounted in 1918–19 to 7.07 per cent. as compared with 4.54 per cent. in 1914. Owing to war conditions, the money could not be spent, but instead of placing it, as in the United Kingdom, to reserve, it was allowed to go in the general administration of the country. Now that works must be carried out and stock renewed, money will have to be borrowed at 7 per cent. instead of 4 per cent. or less. Another factor is the "lapses," whereby any money voted for works and unexpended at the end of the financial year is no longer available, and a new vote is necessary for the continuance of the works. To quote one of several happy similes in the report, this system "assumes that the concern goes out of business on March 31st and recommences *de novo* on April 1st." The powers of the companies and of the Railway Board are absurdly limited. For instance, although some of the bigger companies realise annual gross earnings of between £3,000,000 and £9,000,000, they may not spend £1650 on any one new work without the sanction of the Railway Board. The Board, in turn, has its hands equally tied. In view of these and like defects, it is not surprising that the Committee unanimously recommends great changes. Railways are now represented in the Council by the Member for Commerce, who, having other duties, cannot keep in constant touch with the work of the Railway Board; he can only deal in Council with questions, which may be highly technical, with second-hand and incomplete knowledge. "The Railway Board is, in effect," says the report, "in the position of a step-child, and, like most step-children, tends to be less well-treated than the other children of the family." The Committee is of opinion that railways and other kindred interests are of sufficient importance to merit the appointment of a Member for Communications. The railways should have a separate Budget which should be presented by that Minister and not by the Minister for Finance, and the Railway Board should be replaced by an enlarged Railway Commission, on which there should be a Chief Commissioner and, under him, a Finance Commissioner and three Divisional Commissioners. The last provision would remove the complaint from many districts that the members of the Railway Board seldom or never visit them; the answer to which complaint is that were a member to be absent from his office for a fortnight the accumulation of papers would be so great that it would be almost impossible for him ever to overtake them. Traders and the public should have "an adequate voice in the management of their railways" by the establishment of Central and Local Railway Advisory Councils. Such Councils would represent a new departure so far as railways with British interests are concerned. They are a Prussian institution, and were recommended for use in Canada by Sir William Acworth and his two colleagues in their report on the railways of that country, but have not, we believe, been established there. The present report says, however, that the Committee "understood from the Indian witnesses that they would welcome the establishment in India" of such Councils, and that "all the railway officials to whom we put the question expressed themselves as ready and willing to work with Local Advisory Councils and endeavour to make them a success." Traders, furthermore, should have a Rates Tribunal like that provided for in our own Railways Act. There should be a reasonable general increase in rates and fares, and the surtaxes at present levied should be withdrawn. The final unanimous recommendation is that the system of management by companies of English domicile should not be continued after the termination of their existing contracts, and that those companies should not be permitted to increase their share capital.

Unanimity, however, ceases when the future of the company-worked railways after the expiration of their contracts is considered. The Committee on this point was evenly divided, five favouring the policy of entrusting the lines to the direct management of the State, whilst the other five recommend that the present system of State and company management, but with companies domiciled in India, be continued. In placing a value on these respective opinions, it may be of interest to know that three of the five members who favour State management are, to quote an introductory sentence in the report, "English, with no previous knowledge of India," whilst three of the other five "represent life-long experience on Indian railways." One of the other two of this latter five "represents Indian opinion," and the other "is a representative of the European commercial community in India." We may add that two of the members with life-long experience of Indian railways have been presidents of the Railway Board, and are not therefore necessarily prejudiced towards company management. It may, consequently, safely be said that the weight of experience is against State management. Another objection against the transfer of these railways to the State is the obvious one that all the weaknesses and evils so flagrantly exposed in the report are mainly due to inefficient action by the State. Surely then, anything that favours a continuance of State control should be avoided. Our own experience during the war ought to be an example of what may be expected when the companies are left to manage their own affairs and what happens when the State interferes. It must be admitted that in the present report no charge of inefficiency lies against the State-operated railways; but, on the other hand, there is equally no charge against the company-operated lines. Moreover, there is a touch of humanity, of *esprit de corps*, that comes from working for a company, and that is not experienced when serving the State. India is, and will be for some years, passing through critical political times, and herein is another reason why the Government should move slowly. It may seem

to the politician a desirable thing to concede to the public the entire possession of its railways; but, as is shown in the report, the property has been a source of profit to the country in the past, and there is such a thing as killing the goose that lays the golden eggs. Lastly, there remains the incontrovertible fact that the Committee is evenly divided on this particular question, and therefore, in accordance with the unwritten law, the *status quo* should be retained and the railways continue to be company-operated.

### The Agricultural Tractor.

ONE of the benefits resulting from the war is the awakening of interest in our great farming industry, and especially that part of the industry which relates to the cultivation of the land. During the war the nation had to face both the difficulty of obtaining its usual supplies of foodstuffs from overseas and a shortage of labour both manual and animal for farm purposes. These difficulties were overcome in a large measure by calling in the aid of the engineer, who set to work to develop the mechanical farm tractor, and the rapid rise in favour which this class of machine has made amongst agriculturists may be regarded as a direct outcome of the war. Very few of these appliances were in use prior to 1916, whereas their numbers now run into thousands. By the aid of the tractor, experience has proved that both the cost of cultivation and the cost of "clearing" land can be reduced as compared with the employment of other forms of traction. Experiments carried out at the Rothamsted Experimental Station have proved the value of the tractor in four main directions:—(1) Rapidity of work, (2) clearing of stubbles in the autumn, (3) cost of working, and (4) increase in efficiency of labour. A report recently issued from this source states that in the days of horse cultivation on the heavy loam land of the Rothamsted farm, sowing could not be completed in October or November, and there remained always fields to be sown as late as January or February, according to the weather. Since the advent of the tractor, however, the work has been pushed forward, and the land has all been sown by November. That the sowing was completed several months earlier is purely due to the use of the tractor, and the experiments showed the great advantage derived from sowing seed at the right time. For instance, wheat sown in November was found to yield 26¾ bushels per acre, whilst that sown in February only yielded 19¼ bushels. With regard to the cost, the figures contained in the Rothamsted report for 1920 show that the total cost of ploughing one acre of land by horses amounted to 40s. 9d., whereas the tractor did the same amount of work for 25s. 10d., and the time occupied showed an even greater economy on the part of the tractor, namely, four hours against one and a-half days. It is important to note, too, that included in the figures for the tractor is an amount equal to 25 per cent. of the total cost per acre for depreciation and repairs, whereas no such allowance is made when horses are employed. With such a speeding up of the operations by means of the tractor, the output of the worker is correspondingly increased.

The Society of Motor Manufacturers and Traders deserves much credit for popularising the farm tractor in this country. The trials organised by this body during the last three years have enabled agriculturists to obtain an insight into their construction and operation which would not otherwise have been easily obtainable. They have served to demonstrate the large number of purposes to which the modern agricultural tractor can be applied on the farm and estate. The trials held last week at Shrawardine, near Shrewsbury, were perhaps the most instructive of any which have yet been held in this country. The hauling of the plough and the cultivator, the driving of thrashing machines, straw cutters, presses, saws and pumps were all demonstrated under ordinary working conditions. But perhaps the most instructive features of the trials were the power tests carried out by experts. The engines were all submitted to a belt power test by means of a Froude dynamometer, and the complete machines were all put through a draw-bar test by means of which the overall mechanical efficiency of the tractors was obtained. The figures obtained from the latter tests showed that no matter how efficient the engines are, only a very small proportion of the power available is made use of, owing to the lack of adhesion or gripping power of the travelling wheels. In nearly every test carried out the draw-bar pull was limited by adhesion. Frequently, the draw-bar horse-power on this account reached little more than one-third of that which the motor is capable of developing. This poor result may have been due in some measure to the hard state of the ground, but even granting that that was the cause, better results are looked for. The ordinary road wheel fitted with strakes gave the poorest results. One tractor, the British Wallis, with the aid of deep inverted V-shaped spuds bolted to the wheel rims, gave an adhesion of more than 50 per cent. of the power developed by its engine. The caterpillar or chain track system gave much better results in this connection, and it is probable that if the ground had been very soft the difference in favour of this form of locomotion would have been even greater; but in spite of its advantages the chain track system does not seem to be making the headway which was once expected of it. Out of a total of forty tractors entered in the competition, there were only three of the chain track pattern. The draw-bar tests were all carried out by means of Mr. G. W. Watson's dynamometer, which was designed specially for the purpose. This instrument, in addition to acting as a recorder of the tractive effort and the distance traversed, also acts as a depth-measuring apparatus for the depth of cut. It marks an advance on anything of the kind which has previously been used for a similar purpose, and the records obtained by it should be of great utility.

It is a noteworthy fact that out of the forty machines entered, there was not a single failure. A record of that kind shows how rapidly engineers have assimilated the lessons of earlier trials and of the even more valuable experience gained in daily use. The conditions under which farm tractors have to work are exceptionally severe, for they include not only the rough handling which the machines receive from their proper element—the soil—but, all too frequently, the more trying handling of unintelligent and inexperienced drivers and owners. Hitherto there has been rather too much tendency to break down, and whilst we recognise that test results are very different from day by day results, we may hope that the fact that not a single tractor failed at Shrawardine indicates that manufacturers have by now found out most of the weak spots and eliminated or strengthened them. If that should prove to be the case, then when the problem of adhesion, which has been raised scientifically at these trials, has been satisfactorily solved, the engineer will be able to tell the farmer he has provided him with a satisfactory appliance, and that it is for him to see that it is adequately used, and that farming is modified to take advantage of its superior qualities and to make the most of the benefits it offers.

## The British Association.

No. IV.*

### FORTH AND QUEBEC BRIDGES.

THE evening discourse by Professor C. E. Inglis, comparing the Forth and Quebec bridges, and dealing with the evolution of cantilever bridge construction during the past thirty years, which was delivered on September 9th, drew a large audience. The lecture was illustrated by an excellent series of lantern slides.

The lecturer said that the Forth Bridge was the first example of a great cantilever bridge construction, the Quebec Bridge the most recent. The intervening period of thirty years was one of great activity in the history of bridge engineering, and it was only natural to expect marked differences in the design of the two bridges. The all-important point to bear in mind in contrasting these two great structures was the vast difference in the economic conditions which prevailed in the two cases. The Forth Bridge was constructed at a time when skilled steel work erectors, and plenty of them, could be obtained for about sixpence an hour. Economy in labour was not the all-important consideration, and it was possible and legitimate to indulge in features of design which would in these days have to be ruled out owing to their prohibitive cost. The designers of the Quebec Bridge laboured under modern economic conditions; economy in the methods of manufacture, economy in the labour of erection were primary and pressing considerations, and the main differences between the two structures could be summed up concisely and yet fairly accurately by the statement that the Forth Bridge was made by hand, whereas the Quebec Bridge was to a large extent machine-made.

The total length of the Forth Bridge was, said the lecturer, 2765 yards, the total length of the Quebec Bridge 1079 yards; the greatest span in the Forth Bridge was 1710ft., whereas the clear span of the Quebec Bridge was 1800ft. In one other respect the Quebec Bridge surpassed the Forth Bridge; it was constructed to carry train loads nearly three times as heavy as those for which the Forth Bridge was designed, so that in spite of its comparatively short total length there was actually more steel in the Quebec Bridge than in the whole length of the Forth Bridge, the weight being 66,000 tons as compared with 54,000 tons. The most distinctive feature of the Forth Bridge was the tubular form of the compression members. Throughout the cantilevers all compression members were made in the form of tubes. A tube was ideal for this purpose in that it required little or no additional stiffening to provide the lateral rigidity so essential for compression members. Towards the centre of the cantilever these tubes were 12ft. in diameter. The skin consisted of steel plating 1¼in. thick riveted to ten longitudinal joists, and the only additional stiffening was that provided by annular diaphragms spaced at intervals of 8ft. along the tubes. The sectional area was 800 square inches as compared with 1941 square inches for the corresponding members in the Quebec Bridge. The compression members in the case of the latter bridge consisted of four parallel girders having their webs braced together by central longitudinal diaphragms and their flanges coupled up by a very substantial system of lattice bracing. As in many respects a tube formed the ideal form for a compression member, it might be asked why that ideal was departed from in the case of the Quebec Bridge. The answer was that the methods of manufacture and erection adopted for the Quebec Bridge did not admit of this tubular form of design. The Forth Bridge was built up *in situ*, plate by plate, in much the same way as a ship was built. Cheap and abundant labour was readily obtained from the neighbouring Clyde shipyards, and the number of men employed on the site at one time exceeded 4000. In the case of the Quebec Bridge, owing to the high cost and scarcity of labour and owing to the fact that outdoor work was limited to about six months in the year, field work operations had to be cut down to a minimum. Not more than 400 erectors were employed at any one time. As much work as possible was done in the shops, and the various bridge members were brought to the site as far as possible ready made and in sizes as large as were compatible with railway transport. Leading considerations in the design of the members were ease of erection and transport facilities and the transportation of vast ready-made tubes which, in the case of the Quebec Bridge, might have been 20ft. in diameter, made the tubular form of compression members, no matter how desirable, a practical impossibility.

To facilitate erection, most of the main connections in the Quebec Bridge were made by means of pin joints, whereas in the whole anatomy of the Forth Bridge not a single pin joint was to be found, all the connections being of the rigid riveted variety. The comparative merits of pin joints *versus* rigid riveted joints in a bridge structure was a highly controversial question. Riveting the joints imparted extra rigidity to the structure; pin joints, on the other hand, facilitated erection and gave immunity from secondary stresses. In the case of a pin-jointed structure, angular changes were free to take place, and a pin-jointed structure in consequence possessed the merit of freedom from secondary stresses. But ease of erection was the main consideration which led to the extensive use of pin joints throughout the Quebec Bridge. Ease of erection was also responsible for the K type of triangulation adopted. It was a novelty in triangulations put forward by the St. Lawrence Bridge Company, and it was only accepted by the original board which examined the tenders after a lengthy and almost acrimonious discussion. The claims of its advocates in the matter of ease of erection, economy of material and pleasing appearance had been, however, so amply justified in the case of the Quebec Bridge that it was almost safe to prophesy that the K form of truss would become the standard form of triangulation for the great cantilever bridges of the future.

The upper tension chords of the Quebec Bridge cantilevers were of somewhat novel design. They consisted of a number of flat eye-bars packed side by side in two tiers, and since the distance between adjoining panel points was too long for single-length eye-bars they were made in two lengths connected together at the centre by pins. To prevent a deflection being produced by the weight of these massive pins, the pins were supported by a light rigid steel truss which bridged the gap between adjacent panel points. That truss in no way contributed to the tensile stress of the member. Its duty was merely to support the weight of the central pins, but incidentally it provided a convenient box cage inside which the eye bars could be housed before and after erection.

The cantilevers of the Forth Bridge rested on groups of four piers, whereas in the case of the Quebec Bridge each cantilever was simply hinged to a pair of piers. In the Forth Bridge the stability of the two shore cantilevers was due partly to the fact that they rested on four piers and partly to the fact that the shore ends of these cantilevers were anchored down to the shore abutments. This dual control introduced certain ambiguities of stress, and it might have been preferable to adopt the method followed in the case of the Quebec Bridge and hinge the cantilevers to two piers rather than support them on four. The same criticism did not apply to the central cantilever of the Forth Bridge. That cantilever was not supported at its outer extremities. For its stability it depended entirely upon its length of base, and the length of base provided for that purpose was no less than 260ft.

To provide for the expansions and contractions in the bases of the Forth Bridge cantilevers, allowance was made in the bed-plates for longitudinal and rotational movement relatively to the masonry piers. It would appear, however, that that was an unnecessary refinement; at any rate, there was no evidence

* No. III. appeared September 23rd.

of any relative movement having taken place. The load on a pier was of the order of 5000 tons, but the temperature stresses only had the effect of slightly rocking the masonry piers. Substantial as these piers were, they could not claim to be absolutely rigid, and even in the case of the central cantilever a rocking movement of half an inch out of the vertical was sufficient to free the long base from the temperature stress occasioned by the greatest possible range of temperature.

It was interesting to note that in the first design for a Forth Bridge submitted by Sir Benjamin Baker, his shore cantilevers were shown resting on two piers, and it was apparently out of deference to the wishes of his colleagues that he subsequently adopted the four-pier method of support. Another criticism which had been put forward was that the central suspended spans of the Forth Bridge were made somewhat short from the point of view of maximum economy in material. In Sir Benjamin Baker's first project those spans were 500ft. long, but in the actual bridge they were reduced to 350ft. in length. They were built out as extensions of the main cantilevers, whereas the central span of the Quebec Bridge, which was 640ft. long, was floated ready made to the site and hoisted up bodily into position. As the weight to be raised was 5300 tons, and the height to which it had to be elevated was 150ft., that was a weight-lifting proposition of unprecedented magnitude, and by sheer bad luck the first attempt ended in disaster. Another distinctive feature of the Forth Bridge was its tapering in width in vertical as well as in horizontal directions. Reducing the width in vertical directions was conducive to stability, and was all the more necessary, because the Board of Trade, thoroughly frightened by the Tay Bridge disaster, insisted on the Forth Bridge being designed to withstand the excessively high wind resistance of 56 lb. per square foot. Modern specifications usually called for a resistance of 30 lb. per square foot. Reduction in width in horizontal directions had the effect of greatly reducing the weight at the centre of the span just where reduction in weight was most desirable. In spite of these advantages this tapering in width in all directions had probably to be classified as one of those refinements which would have to be ruled out nowadays owing to its prohibitive cost. It added greatly to the labour of erection, as every joint became a complicated intersection. Vertical members and right-angled intersections were sought for almost in vain in the Forth Bridge, and every joint was a direct encouragement to the study of three dimensional geometry. The trusses of the Quebec cantilevers were vertical and parallel to one another. The heavy vertical members, being truly vertical, were comparatively easy to handle, and the parallel configuration of the top chords provided a convenient track along which the overhead traveller advanced as the work of construction proceeded.

The final comparison made by Professor Inglis related to the efficiencies of the two bridges, *i.e.*, the ratio of the dead load to the live load. Leaving out of account the approaches in both cases, the ratio for the Forth Bridge was 4.7, whereas the Quebec Bridge put up the slightly better ratio of 4.4. It must, however, be remembered that owing to the excessive resistance to wind pressure insisted upon by the Board of Trade, the Forth Bridge in this comparison was penalised to the extent of several thousand tons of useless material. If that useless dead load could be discarded the efficiency ratio of the Forth Bridge would undercut that of the Quebec Bridge, notwithstanding the fact that in the case of the latter nickel steel was used for the suspended span, whereas the Forth Bridge was entirely constructed of low carbon mild steel. Taking, however, the ratios as they actually came out—4.7 and 4.4—the fact remained that the efficiencies of these two bridges were almost identical, and having regard to the difference in their ages, and taking into consideration the thirty years of active bridge evolution which intervened, the high efficiency attained by the Forth Bridge was a truly remarkable achievement.

## SECTION C.

### Scottish Oil Prospects.

A general discussion took place on the prospects of new oil discoveries in Scotland.

Mr. H. M. Cadell said that if the great expenditure on exploration had not proved remunerative it had at least provided much interesting geological information. Dealing with the evidence derived from recent bores in the carboniferous series, the speaker said he had been driven to the conclusion that the geological evidence was all against the occurrence of a workable petroleum field in Scotland. A popular idea prevailed that where oil shale existed oil should also be found in the liquid condition. That was an erroneous impression. His view of the origin of the oil shales was that they were fine sheets of clay deposited under particular conditions along with black vegetable mud from a peat-covered land. Mr. Cuninghame Craig, who was an oil expert of wide experience, had, however, disputed this hypothesis, and assumed the existence of a large supply of natural oil which, by some mysterious process, left its original pervious stratum and was intruded into the most impervious strata in the formation. That was the theory which found favour with the Government during the recent oil fever. When the deep bores had been started at West Calder and D'Arcy in 1919, he had taken up the unpopular attitude of predicting the complete failure of the attempt to find petroleum. Similar predictions had been made with regard to the Derbyshire borings, and had been justified. There had been a great waste of public money in those ill-guided ventures. There was, however, a field for successful scientific technology in the peat moss deposits of Scotland, and there was ground for hope that that source of oil and other products might be developed.

Mr. Cuninghame Craig expressed regret that Lord Cowdray had had to rely on American advice for his explorations in search of oil. The Americans who had been called in had been more hopeful than the conditions warranted, for the reason that while they were experts on the subject of oil, they were not acquainted with local geological conditions. He personally believed there was a better chance of finding oil in Scotland than in England, and records were to hand of crude oil discoveries in several districts. With regard to the D'Arcy bore, which at present had only been sunk to 1200ft., the first chance of reaching oil would be at 1500ft., and the second chance at double that depth. It was possible, however, that even if oil were tapped it would only be residues, the main deposit having been removed by water and gradually dissipated.

Sir Aubrey Strahan defended the action of the Government in allocating funds for the search for oil, with the object of proving once and for all whether any concealed reserves of oil existed in the country. It was work which ought to be done, but it was questionable whether the grant of £1,000,000 for the purpose was the kind of expenditure which could be justified.

Dr. T. S. Flett referred to the difficulties which had been experienced with the West Calder bore, where work would in all probability be discontinued in the near future.

## SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

### Breakage of Submarine Cables.

In a report on seismological investigations comment was made on work done with the object of ascertaining the cause of the breakage of submarine cables. It was, the report states, Milne's opinion that submarine earthquakes were often responsible for breakage of cables. During the past year opportunities had arisen in several independent ways for testing this hypothesis. In some cases definite dates and places of cable breakages were supplied, with inquiries whether shocks fitting in with these data had been recorded. In no case could an affirmative answer be given after scrutiny of the records; while in some of them the trace seemed to be almost maliciously quiet for many hours near the date and time provided. After some experience of this kind other inquiries were initiated by the chairman (Professor H. H. Turner) without better success. The cable companies concerned did not wish the details published, for business reasons; but the main facts were as stated. It would seem that if submarine shocks of the kind were responsible for cable breakage, then for some reason they did not affect seismological records.

### Power from Sewage Gas.

The possibility of utilising sewage gas for power purposes was raised in the light of recent experiments by Mr. J. D. Watson, engineer to the Birmingham, Tame and Rea Drainage Board.

The author claimed that proof had been given in tests he had carried out at Birmingham that it was practicable and economical to drive a suction gas engine by gas derived from sewage sludge. Economists would, he thought, be interested in the achievement of utilising the gas to operate plant which formed an essential part of an installation for the purification of sewage. The volume of wet sludge dealt with at Birmingham was 400,000 tons a year, and he estimated that 9000 tons of dry solid matter were available to produce 320 million cubic feet of gas, which gave 16 million horse-power-hours at 20 cubic feet per brake horse-power. That was equivalent to 4400 horse-power per day of ten hours. Reports from New South Wales indicated that the yield of gas from sewage might reach a far higher value, but he preferred to take the Birmingham figures, and they suggested that considerable power resources were being wasted by our great cities. London dumped two million tons of wet sludge at sea every year, and 400,000 tons were similarly disposed of by the Corporations of Glasgow and Manchester.

The plant which had been installed in the Birmingham experimental station at Cole Hall had been set up in an area where neither electric nor coal gas power was available. It was designed to give 25 brake horse-power for a working period of six hours a day. At the present time it was being operated under disadvantageous conditions, partly owing to want of knowledge of the precise requirements of a sewage gas plant, and partly for the reason that the gas holder, which must be regarded as an essential feature of an installation, where gases of varying quality had to be diffused, was not yet available, its erection having been delayed pending a decision on the basis of early tests whether the expense of a gas holder would be justified. Notwithstanding that and other handicaps, the trial runs of the engine and pump which it was designed to drive had been most successful, and the cost of producing the gas low. The engine was of the ordinary standard town gas engine type, capable of giving 34 brake horse-power as a maximum on town gas having a calorific value of 500 to 550 B.Th.U., and judging from the experience gained it was hoped that the gas available would have a calorific value of 650 to 700 B.Th.U.

Mr. Watson thought he was justified in claiming that it was not necessary to possess the Indian or Australian climate to obtain power gas from sewage, and it was the duty of all local authorities in these days of enforced economy to see that the power resources available in sewage gas were not wasted.

### Incrustation of Pipes.

Iron bacteria in relation to the incrustation of pipes—a subject of considerable interest to the engineer—was discussed in a short contribution by Dr. David Ellis, who has for the past twelve years been engaged in the study of iron bacteria from all parts of the world.

There was no time, said the author, to traverse the whole subject, but out of a welter of controversy had emerged the salient fact that the iron bacteria were saprophytes, and as such required organic food for their nutriment. The question for each water engineer to determine, therefore, was whether the water which was under his care contained enough organic matter to supply these needs. The amount of this organic matter should be determined by bacteriological, not chemical analysis, on account of the greater delicacy of the former method of testing. Further, the water engineer must ascertain whether the mineral ingredients in the water were such as to favour the growth of the iron bacteria. Another consideration was that acid waters were more favourable to the iron bacteria than alkaline waters in which the chief salts in solution were compounds of sodium and potassium, or soft siliceous waters such as were found, for example, in the Manchester water supply. A third fact, the importance of which had only lately been realised, was that iron bacteria could and did multiply independently of the presence of iron.

Practical problems centred round four different kinds of growths: (1) slimy streamers; (2) tubercular incrustations; (3) iron incrustations on non-ferruginous surfaces; and (4) spongy disease of cast iron. The first owed their existence entirely to the activities of iron bacteria and other organisms; the formation of tubercles was dependent on the presence of $CO_2$ in the water; the incrustations which formed on non-ferruginous surfaces must obtain their iron from the water, and were not, therefore, entirely due to iron bacteria; spongy disease of iron was not in any way due to iron bacteria. With regard to the remedies to be employed, each water supply must be considered on its merits. The removal of slimy streamers must be governed by knowledge of the iron bacteria. It must first be ascertained that the organisms concerned were iron bacteria. If that was proved it became the duty of the water engineer to remove, if possible, every factor favourable to the life of such bacteria. The most obvious method was, of course, the removal of organic matter from the water. That could be done by aeration. If that were done and precautions taken to protect the gathering ground from organic contamination, a proportion of iron in the water of one in a million parts need not cause any anxiety. There should be periodical biological as well as chemical tests for water reservoirs. The following tests should be conducted periodically:—(1) The amount of organic matter as determined by the number of bacteria per cubic centimetre that the water can support; (2) the acidity of the water; and (3) the organisms that are established in the reservoirs and conduits; and particularly the iron bacteria that are normally present in the conduits.

## THE INDUSTRIAL PRODUCTION OF RARE METALS.

Though Moissan, with his oxygen-blast electric-furnace temperature of 3500 deg. Cent., was able to fuse chromium, titanium, molybdenum, vanadium, boron, zirconium, tungsten, and uranium, the quantities dealt with were minute, and the full development of such metals has awaited a method of melting on an industrial scale. After years of experiment, Hugo Lohmann reports, according to the *Chemical Trades Journal*, having reached a solution of the problem. By an aluminothermic furnace, depending on the heat of the reduction of metallic oxides by aluminium, he has liquefied 12 lb. of chemically produced amorphous tungsten in 15 min., obtaining a thoroughly fused carbide; and in like manner has produced carbides of titanium, vanadium, zirconium, silicon, boron, and uranium in important quantity. To produce tungsten metal free from carbon, the aluminothermic furnace was combined with the electric arc. The great difficulty was to control the violence of the aluminothermic reaction, but success in this is claimed to have opened the way to produce for industrial use a series of metals of very unusual properties. The tungsten carbide, it is believed, may be made the hardest substance known. It is rated at 9.8 of the Mohs scale, but the addition of carbon and rolling or forging is expected to raise this hardness above the 10 of the diamond.

# American Pipe Lines for Pumping Oil.

No II.*.

In the previous article reference was made to general lines of practice in pipe line work. It is now proposed to deal with some recent examples.

### Coalinga Valley Pipe Line.

A special and very unusual feature in the 170-mile pipe line of the Valley Pipe Line Company from the Coalinga Oilfields, in California, to a refinery at Martinez, on San Francisco Bay, is that a combination of 8in. and 10in. pipe is used to facilitate the pumping of heavy oil. The smaller pipe is employed for 66 per cent. of the distance between two pumping stations, the larger pipe being then used for the remainder of the distance, where the oil is relatively cool and of greater viscosity. This pipe line was built in 1915 under the direction of Sanderson and Porter, of San Francisco, as engineers for the Shell Company of California.

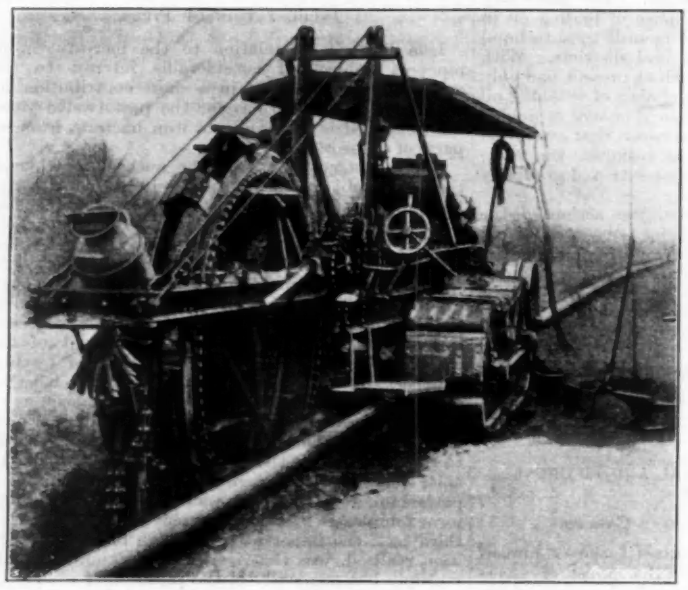


FIG. 5—TRENCH EXCAVATOR WITH PIPE READY FOR LAYING

Self-propelling petrol trench excavating machines were used for constructing 150 miles of the line, these machines being of the type having buckets attached to the rim of a large rotating wheel which lies in the trench. One of these machines is shown in Fig. 5, making the trench for a pipe line already connected up. Hand excavation was employed on 20 miles of trench in rough country. On the entire line the jointing of the pipe was done by machines of the type previously described, there being one machine for the 8in. and one for the 10in. pipe. A force of about twenty-eight men worked with the machine. Since clean threads are essential to ensure tight joints, men were sent in advance of the machine to remove any dirt and the protective grease from the threads by means of petroleum distillate and wire brushes. Just before the threaded end of the pipe was entered into the collar of the preceding pipe both pipe and collar were coated with a lubricant to prevent the collar from heating under the friction experienced when the pipe was screwed home. The average progress of jointing was 4196ft. per working day, the highest records being 5700ft. for the 10in. and 8700ft. for the 8in. pipe.

After the jointing had been completed the pipe on each pumping division was submitted to a hydrostatic test pressure of 900 lb. per square inch, continued for four hours. During this test period all the joints were inspected carefully, but in a stretch of 140 miles only three joints were found to require caulking.

Numerous vertical and horizontal bends were required in the part of the pipe line passing through rough country. These bends were made by utilising the weight of the jointing machine, the pipe being heated only for bends of large angles. For this work the machine was placed at the middle of the last length of pipe and was raised to its highest position on the supporting spuds. Blocking was placed to support the pipe at the point where the bend was to be made, and the pipe was also gripped by tongs to hold it steady. The jointing machine was then lowered so as to bring its weight on the overhanging length of pipe, while as many men as possible stood on the pipe beyond the fulcrum blocking. If the bend was for an uphill curve or a lateral curve it was made in the same way, the pipe being then turned to the desired position.

After careful consideration of different protective coatings for the pipe it was decided to use an English bitumastic enamel made by Wailes, Dove and Co., of Newcastle-on-Tyne, this enamel having been used on other pipe lines and adopted by the United States Government for the protection of the steel gates of the Panama Canal. The cost was about the same as for the asphaltum and paper wrapping mentioned previously.

To apply the coating the contractor devised machines which surrounded and travelled along the pipe in the same manner as the joint screwing machine already described. The machine for applying the priming coat had at the front end a revolving circular or annular brush and scraper, concentric with the pipe, which removed the dirt and mill scale. At the rear end was a similar brush wheel running at sufficient speed to feed the priming to the ends of the brushes by centrifugal force. Two men operated the machine, which was driven by a 6 horse-power petrol engine and carried three tanks for the priming solution, the water, and the petrol.

In from two to four hours, depending upon the weather, the priming coat had set, and a second machine of somewhat similar construction was run over the pipe line to apply a ¼in. coating of the bitumastic enamel. This machine, however, was not self-propelling, but was driven by a crank handle and gearing. It was supplied with molten enamel from large kettles or melting pots mounted on wheels and heated by petroleum distillate. This coating was smoothed and touched up by hand behind the machine, where necessary, an inspector following the work closely and using a mirror on a rod for inspecting the underside of the pipe.

On this work the trenching was done in advance of the pipe laying, so that when the pipe line was connected up and ready for the application of the coating it lay on wooden transoms or sills placed across the trench. To allow the coating machines to pass these supports the pipe was raised by three men with a long lever mounted on an axle and wheels for transportation, the lever having a chain sling attached to the end of its longer arm and covered with rubber hose. When the pipe was lifted slightly the sill was removed from in front of the machine and replaced behind it, the pipe being then lowered and the machine proceeding until the next sill was encountered.

Lowering the coated pipe into the trench was the next operation, and was done by means of a sling on a cable leading over the pulley at the apex of a wooden tripod or three-legged derrick which straddled the trench. The cable was wound upon a drum or winch carried by a shaft across the two legs on one side of the ditch. The winch was operated by a pair of light iron wheels 4½ft. in diameter, instead of by crank handles, these wheels also serving as a convenient means of moving the tripod from place to place.

With the pipe line lying in the trench it was thrown to each side of the trench alternately so as to form a sinuous line to allow for longitudinal expansion and contraction movements. Filling material was deposited at intervals of 30ft. to 50ft. to hold the pipe in its curved alignment. Finally, the back filling of the trench was completed by a petrol-operated machine which straddled the trench and had endless chains placed horizontally and transversely to the line of the trench. To these chains were attached scraper blades or buckets which scraped the material from the spoil bank into the trench.

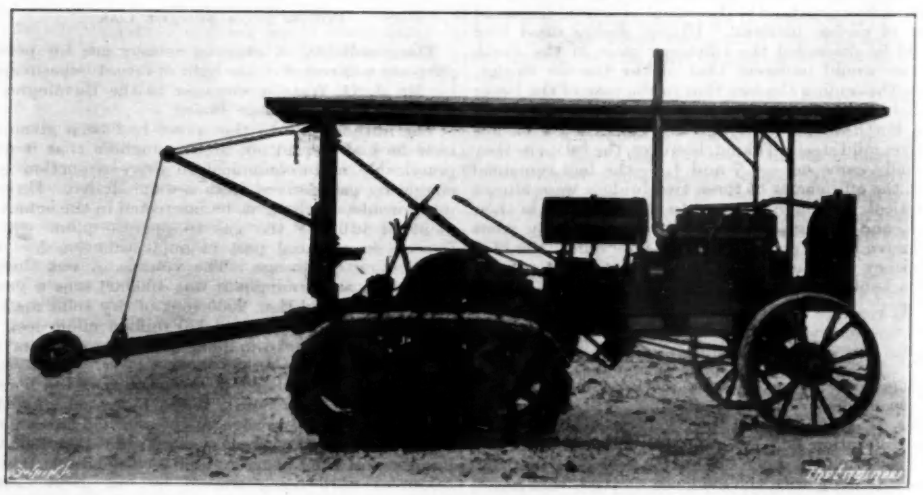


FIG. 6—BUCKEYE PETROL-DRIVEN PIPE JOINTING MACHINE

### The Yarhola Pipe Line.

An oil pipe line of much greater length and more recent construction than the Coalinga line described above is that of the Yarhola Pipe Line Company, which extends from Healdton, in the oilfields of Oklahoma, across the States of Oklahoma and Missouri, to a refinery at Wood River, in Illinois, a distance of 555 miles. There are nine pumping stations equipped with Diesel engines for the pumps and having an aggregate capacity of 5500 horse-power. The same firm of engineers—Sanderson and Porter—designed this pipe line and supervised its construction.

The first stretch of 130 miles, from the Healdton oilfield to a temporary refinery at Cushing, consisted of 6in. pipe with two pumping stations—later increased to four—the transporting capacity being 5500 barrels of oil daily. As soon as this work was under way plans were made for the remaining 425-mile portion. This line was of 10in. pipe and had five pumping stations, as it was designed to deliver 25,000 barrels daily at the Wood River refinery.

Pipe jointing was done by machine where practicable, but in rough and hilly country the pipe was screwed up by gangs of men with pipe tongs, because of the difficulties of handling the machines in such country. On the Healdton–Cushing section, where the jointing machine was used exclusively, a record was made of 11,740ft. of 6in. pipe connected up in nine hours by a crew of twenty-six men. In addition, no less than twenty-eight bends were made in the pipe. On the 10in. line from Cushing to St. Louis, the highest record was the jointing of 8200ft. of pipe and making twenty-four bends by a crew of thirty-six men. In both cases the work included cleaning the pipe and painting it with a coal-tar protective coating. As each section of the line between two pumping stations was completed, it was filled with water and subjected to a test above the operating pressure by means of the station pumps.

To make bends in the pipe, a screw jack was mounted upon it and secured in position by a rod passing over the jack and having its ends clamped to the pipe, so as to form a sort of kingpost truss. A flexible shaft driven from the petrol engine of the jointing machine was then employed to operate the jack and bend the pipe to the required extent.

On this line the trench was excavated by a trenching machine of the wheel type, the pipe on the surface lying between the excavating wheel and one of the caterpillar supports of the machine. The pipe was laid deep enough to permit of any kind of agricultural work being carried out above it. In crossing the Mississippi River, near St. Louis, the pipe was laid on the bed of the river, the joints being connected up on a barge and reinforced by long sleeves clamped over them, as illustrated in the first article. Each sleeve was made in three longitudinal parts having a concave web to fit the pipe and two outstanding flanges. When these flanges were tightly bolted together the clamp exerted a powerful grip. There is also at the shore connection a slip joint in a bolted stuffing-box to take up longitudinal movements caused by temperature changes.

### Distribution of Material.

When the land or right-of-way had been obtained for the Yarhola pipe line, about 80,000 tons of pipe had to be distributed, the average haul or load being about 9 miles from a railway station. The roads

* No. I. appeared September 16th.

were poor and the strengthening of a number of bridges and culverts had to be undertaken. In accordance with western practice, the hauling was done with pairs of wagons coupled together in tandem, each pair being handled by a long team of eight to twelve horses or mules, in charge of a single driver. The loads were arranged to give an average of 1500 lb. for each animal, two wagons loaded with 18,000 lb. of pipe being hauled by twelve mules. Similar methods were employed on the Coalinga line, from eight to ten of the eight-mule teams starting from the railway station early in the morning, distributing their loads and getting back before night.

In distributing material for the pumping stations of the Coalinga line, the distances from the railway ranged from 5 to 20 miles. In the light sandy soil along the southern portion of the line, with numerous streams to be crossed, motor trucks were useless in the wet season, and could carry only half their rated loads at other times. On the northern section the black soil became almost impassable even for motor vehicles in wet weather. Most of the hauling was done, therefore, in much the same way as the pipe distribution, using two wagons coupled together and attached to a team of eight mules with one driver. The loads were arranged to give from 1000 lb. to 1600 lb. per mule, according to the condition of the weather and roads. The usual trip was 20 miles in a working day.

Hauling of the boilers and heaters required special methods, as they weighed about 13½ tons each. The bodies of two strong wagons were removed, and a heavy timber or bolster was laid across the wagon bed. Upon these bolsters rested a pair of long timbers 12in. by 12in. in section, the boiler or heater being slung from them by chains so as to hang between the two wagons. With the roads in fair condition, twenty-eight mules could handle these loads. Each such unit was in charge of three men—the driver, an assistant, and a man to steer the rear wagon and handle the brakes. After heavy rains, with the roads cut up badly by traffic, fifty mules had to be allocated to each load, twenty-six on the main hauling chain and twelve on each of two chains attached to the sides of the boiler or heater. Hauling such loads on narrow and steep roads with numerous bends was difficult work, but was accomplished without mishap. In all, about 48,000 tons of construction material, supplies and fodder were hauled, representing an aggregate of 512,000 ton-miles.

For the Coalinga pipe line, telephone wires were strung as soon as possible on the cleared right-of-way, using 25ft. wooden poles spaced 200ft. apart, the butts of the poles being coated with carbolineum as a preservative. This 200-mile telephone line gives direct communication between the oilfields, the pumping station, the refinery at Martinez and the company's main offices in San Francisco. There is also telegraph communication between the oilfields, the refinery and the main offices. This equipment facilitated the work of construction, and enables the officials to exercise close control over the operation of the pipe line.

As noted already, it is the general practice for pipe line companies to erect private telephone and telegraph lines along their property or right-of-way in order to have means of instant and regular communication between the several stations and offices, to ensure proper handling of the pumping operations, and to provide against accidents and emergencies. The line walkers who patrol the pipe line also look after the wires, and booths or pole attachments at intervals enable these men to communicate with their headquarters when necessary.

### PIPE JOINTING MACHINE.

A pipe jointing machine used for screwing up the threaded steel pipes of oil pipe lines is shown in Fig. 6. The petrol engine drives through a clutch a shaft which is connected by a universal coupling to an outboard shaft supported by a light cable and jib or outrigger. On the end of this outboard shaft is a clamp which grips the pipe and screws it into the socket of the previous length. The Buckeye Traction Ditcher Company, of Findlay, U.S.A., is the builder of the machine illustrated, the design of which is adapted from the company's trenching machine used in cutting ditches or trenches for oil, water and gas mains, sewers, land drains and similar work.

## The Society of Technical Engineers.

THE Society of Technical Engineers is composed of those persons in the engineering industries who come between the employers and the artisans and clerical staff. The members are, we understand, required to be competent technical men and units of the "salaried class." They form what has been called "A Third Party in Industry." The Society has been in existence for some time, but only within the last few days has it declared its policy. We print its own statement below and leave it, for the time being, without comment. We may remark, however, that whilst the Society is a trades union, it does not propose to exercise the familiar trades union methods of securing its ends; rather, so the secretary informs us, will it seek to encourage Labour to forego part of its policy—ca' canny and restriction of output—and try to bring it to the knowledge that by a union with technology it stands to gain. It will, in other words, endeavour to induce Labour to accept all the advances that technology can offer and make the highest use of them.

Our policy, that is to say, the combination of the objects and the methods of the Society, elaborated after much labour and now adopted by these diverse elements, may be briefly summarised as follows:—

(1) The Society has recognised and agreed that its objects fall into two groups: the first, objects connected with the interests of individuals and of the profession; the second, those connected with the advancement of the British engineering industries.

(2) In the next place, it has been decided that in every action taken to secure any of the objects in the first group, i.e., the interests of individuals and of the profession, consideration will be given to the effect of any such action on the firm to which the members concerned belong, and also that the interests of the industry in general shall be kept in mind.

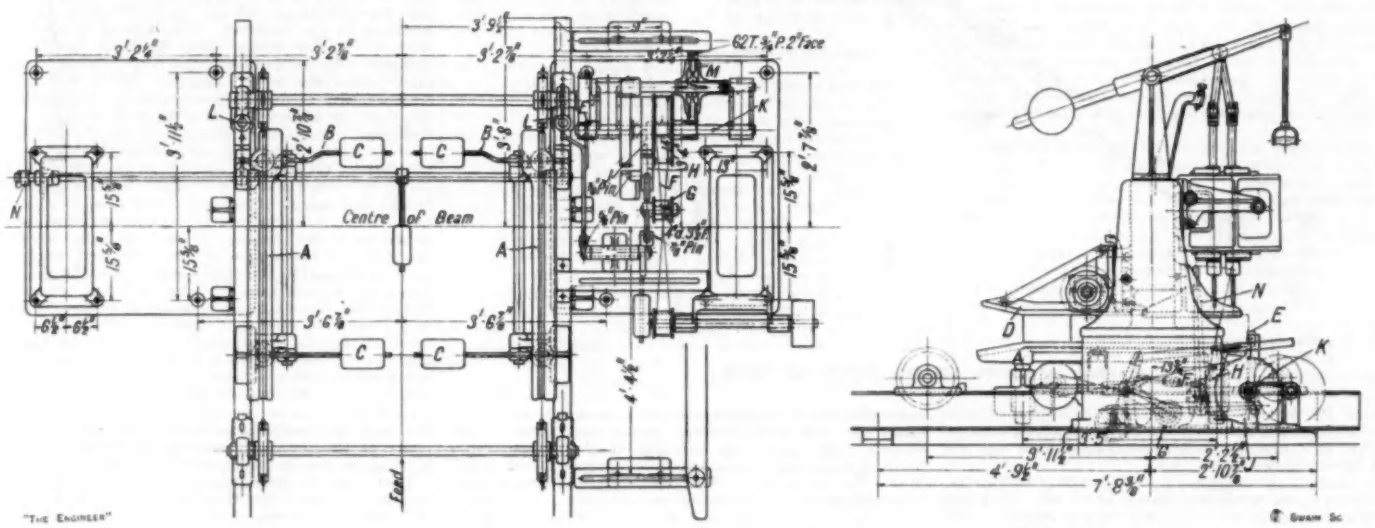
(3) Lastly, we have come to decisions as to our relations with employers on the one hand and with the manual workers on the other. In regard to the former the Society will attempt to establish communications with employers and with organised employers in pursuit of both groups of its objects. In dealing with the manual workers, however, while the Society will not associate itself with the labour movement, nor seek to join the Trade Union Congress, nor make common cause with the trade unions of the manual workers, even with those connected with the industry, in pursuit of improved conditions of service, it will, nevertheless, most earnestly seek to find some means of co-operation with unions of manual workers connected with the industry, in pursuit of the second group of its objects, namely, those concerned with efforts to secure the advancement of the engineering industries of the British Empire.

These being our decisions, it follows that the policy of the Society is, for the present, to secure that technical engineers shall occupy and preserve a position intermediate between employers and workpeople, both within the firms with which they are associated and in relation with the organisations of employers and the organisations of manual workers. For our Society wishes to see the establishment of joint councils of employers and technical staff, in suitable firms, and hopes that such councils will, in the course of time, come to discuss not only questions touching the conditions of service of the staff, but also questions of technical engineering interest. The Society would also welcome the constitution of joint committees of technical staff and manual workers to consider means whereby the industry might be advanced.

The Executive Council has always been clear on one point. It is essential that no ground be given to the common suspicion among the manual workers that the S.T.E. is a cleverly concealed move on the part of the employers. The A.S.E. may safely permit members who are promoted to be foremen, or who rise to occupy positions of managerial responsibility, or become even directors or owners of manufacturing concerns employing manual labour, to retain their membership of the union. But, at present at any rate, the position of the S.T.E. is not strongly and clearly enough established to allow of this. As a consequence the Executive has already had to forego the services of three of its most effective members since they have become directors of concerns employing technical engineers and manual workers. We have now, with equal clearness, defined our position in regard to the manual workers.

## Cross-Cutting, Adzing and Boring Machine for Railway Sleepers.

THE machine illustrated on page 348 and below has been built for the Indian State Railways by Thomas Robinson and Son, Limited, Rochdale. It is designed for cross-cutting and boring sleepers up to 10ft. long, 10in. wide, and 6in. deep, and will adze rail seatings up to 10in. wide and 16in. long. Eight boring spindles are provided, four for each side, with universal adjustment. It will be observed that the cross-cut saws are placed directly in front of the adzing heads, and that the feed chains are extended to the front or in-feed side of the machine for carrying the sleepers past the saws. The cross-cutting attachment comprises two saw spindles with steel tables, which are hinged to enable the saws to be easily changed, the tables being arranged to carry the usual saw packings. Each complete spindle, the table, and the frame carrying the bearings, can be adjusted to suit sleepers of varying lengths. The spindles are independently driven by belt from an overhead countershaft common to the whole machine. The saw spindles run in ring-oiled bearings. After feeding the sleeper past the cross-cut saws the chains carry the sleeper under the adzing cutters. In this section of the machine the chains and sleepers are supported on a flexible bed to allow for unequal and varying thicknesses of the sleepers and to ensure that the adzed




SLEEPER CUTTING, ADZING AND BORING MACHINE

seatings and bored holes are maintained in correct alignment irrespective of irregularities in the material.

Referring to the drawings on this page, it will be noted that the chains and sleepers are supported by the rails A A, which are counterbalanced and weighted by the levers B and weights C, so as to ensure that the seatings and bored holes are kept in correct alignment irrespective of any irregularities in the sleepers themselves. The adzing blocks are machined out of steel forgings, and operate with a shear cut. They are also fitted with shoulder or scribing cutters to give clean ends to the seatings. Each cutter head has a shoe D adjustable vertically, against which the upper surface of the sleeper is held by the rails A in order to determine the depth of the adze below the surface of the sleeper. The sleeper being fed forward from the adzing heads to the boring spindles engages a trip lever E, which slackens the feed belt F by means of the jockey pulley G, and causes the brake shoe H to engage the drum J on the feed pulley shaft K, which drives the chain feed gearing. This trip is timed so that the sleeper comes automatically to rest against a pair of vertical stops L directly in the path of the sleeper, any over-run that may take place in the gearing being accommodated by a slipping plate clutch M, thus preventing jambing and subsequent breakage of the gearing. The sleeper having come to rest, the boring spindles and augers are pulled down by hand levers, and after they have returned to their normal position the operator depresses the two stops L by means of the lever N. This action also releases the trip E and brake H from the feed motion, and puts the belt tightener G into action, thus starting the feed chains into motion again and delivering the adzed and bored sleeper from the machine. The process is then repeated indefinitely.

A special feature of the machine is the method employed to drive the boring spindles. This method consists of a series of four endless roller chains running in horizontal paths, each chain being arranged to drive two spindles. The four chains are of Renold's bush roller pattern, ¾in. pitch, and are driven by the central vertical shaft shown in one of the views on page 348, below the gear-box carried on the bridge casting of the machine, the sprocket wheels being of steel. The gear-box contains a pair of mitre wheels running in an oil bath, the horizontal shaft being fitted with an outside driving pulley to receive motion by belt from the overhead countershaft. We are informed that this system of chain driving has been found quite successful for the boring spindles of this class of machine, and the makers have now adopted it as standard in cases in which universal adjustments of the spindles

are necessary. It is a great improvement over a belt drive in cases in which the spindles have to be adjusted as closely together as 3¼in. between the centres. In such instances the life of the belts would be very short indeed owing to the small diameters of the pulleys necessitated by the short distances between the spindles. The boring spindles are splined in steel bushes mounted in phosphor-bronze bearings, and the crossheads or trunnions at the top have a ball bearing connection to each spindle to take the thrust. These trunnions are linked to the overhead rocking shaft by which the spindles are lowered to their work, the links being arranged to adjust themselves automatically to the setting or spacing of the holes required. The spindles are adjustable transversely with regard to the sleeper from 3¼in. to 6in. centres, and longitudinally from 4¼in. to 14in. centres in each head.

## A Level Luffing Crane.

THE crane shown in the accompanying engravings, which has recently been supplied to the Great Western Railway Company by the Wellman Smith Owen Engineering Corporation, Limited, of King's House, Kingsway, London, is of the type briefly described in connection with a patent specification in our issue of March 25th last, the outstanding feature of which is the arrangement

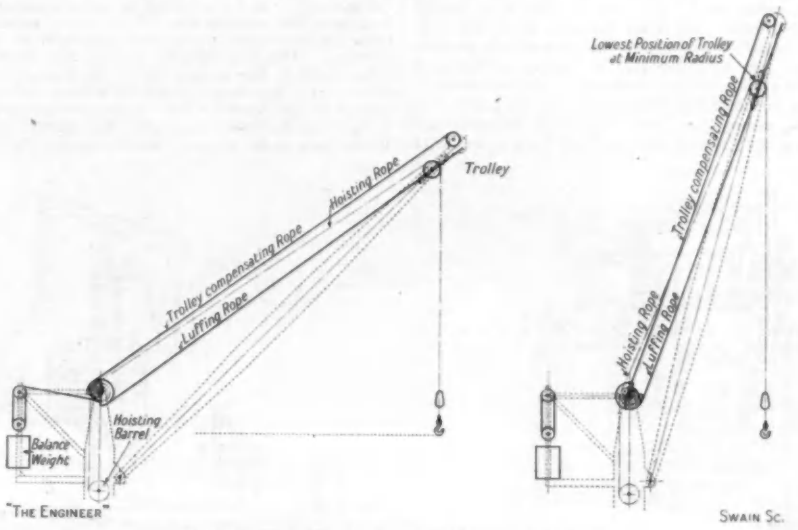



DIAGRAM OF LEVEL LUFFING ACTION OF CRANE

provided for moving the load along a horizontal path while the jib of the crane is being luffed. Such an arrangement has, of course, the merit that it saves both time and power in manipulating the crane.

The mechanism employed for level luffing in the case under review, which has been invented by Mr. J. Jardine, can be best followed with the aid of the line drawing. The hoisting rope and winch are quite normal, but the sheave at the top of the jib, over which the hoisting rope is rove, is mounted in a sliding carriage instead of being fixed on a pin in the jib head. This carriage is so controlled that it moves away from the jib head, as the jib is luffed up, to such an extent that the end of the hoisting rope moves along a horizontal path, although the jib head rises during the process.

This control of the carriage is effected by a pair of ropes, the uppermost in all three illustrations, which are fixed to the carriage, lead up over sheaves at the extremity of the jib, and then downwards to cams on a shaft at the top of the crane framing. On the same shaft there are two drums for the ropes used to luff up the jib. The shaft is driven by bevel and worm gearing from a motor in the cabin. It will be noticed that the luffing rope and that controlling the carriage are wound round the shaft in opposite directions, with the result that as the luffing rope is drawn in, to raise the jib, the carriage is lowered away. The shape of the cam is so devised that the load travels in a horizontal direction until the jib is luffed up within a few feet of the minimum radius. There is then a slight tendency to raise the load, so that an automatic braking effect is produced, and the jib is brought to rest gently. The action is, of course, similar but reversed, as the jib is let out. There is a counterweight, hung on ropes wound round cams on the luffing shaft, to balance the weight of the jib.

The actual crane referred to above is capable of lifting a working load of 3 tons at a maximum radius of 41ft., and is, as will be seen from the engravings, of the slewing jib type with an open portal gantry. It travels on four double flanged cast steel rail wheels placed at 26ft. 7¾in. centres to allow of two lines of wagons passing underneath. It will be observed that the crane has four separate motions, viz., hoisting, slewing, luffing and travelling, each of which is actuated by a separate motor. The general particulars may be enumerated as follows :—

*Capacity and Dimensions.*

| | |
|---|---|
| Maximum working load | 3 tons |
| Maximum radius | 41ft. |
| Minimum radius | 20ft. |
| Total height of lift at maximum radius | 90ft., *i.e.*, 40ft. above and 50ft. below rail level |
| Gauge centre to centre of travelling wheels | 26ft. 7¾in. |

*Speeds and Powers.*

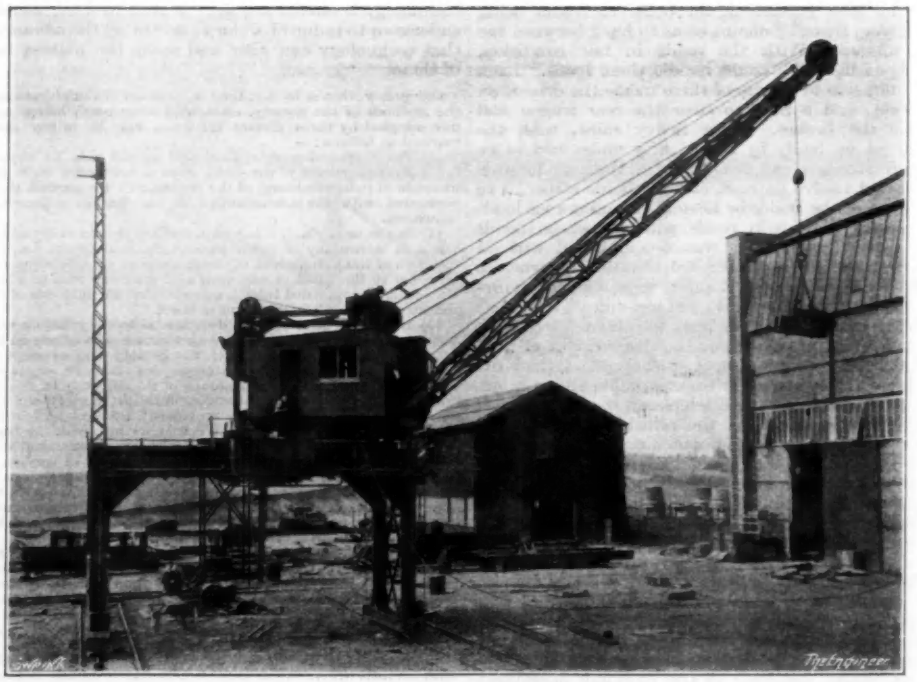
Maximum working load at maximum radius—

| | Per min. | |
|---|---|---|
| Hoisting | 80ft. | 25 B.H.P. at 625 r.p.m. |
| Slewing | 2 revs. | 10 B.H.P. at 600 r.p.m. |
| Luffing | 90ft. | 5 B.H.P. at 600 r.p.m. |
| Travelling | 100ft. | 10 B.H.P. at 600 r.p.m. |

The electrical equipment is designed for a direct current of 220 volts, and may be briefly described as follows :—The motors, of the British Thomson-Houston Company's manufacture, are of the reversible, totally enclosed, series wound type. They are capable of giving a full load output continuously for a period of sixty minutes, with a temperature rise not exceeding 45 deg. Cent. above that of the surrounding atmosphere. The controllers are of Allen West and Co.'s manufacture of the enclosed, reversible drum type. The hoisting and slewing controllers are combined together and operated by a universal handle, the movement of the handle being in the same direction as the movement of the load produced by it. The hoisting controller is adapted for dynamic and potentiometer regulation of the lowering speed with any load and on any contact of the controller. Series regulation governs the hoisting speed and the first contact on the controller permits a slow speed of operation. The potentiometer system of control places the armature and armature resistance in parallel with the series field brake, and a separate control resistance, the result being an automatic regulation of the motor. Light loads are driven in the lowering direction, whilst loads of greater magnitude overhaul the hoisting gear and convert the motor into a generator, the energy of the falling load being dissipated through the resistances. The motor is always across the mains, and the load is therefore under complete control from the maximum to a minimum or "creeping" speed. The maximum lowering speed on the last contact of the controller under full load does not exceed two and a-half times the maximum hoisting speed under similar conditions. The maximum lowering speed with an empty hook is twice the maximum hoisting speed with a full load. The motor is therefore adequately protected against excessive speed in the event of the controller being operated by an inexperienced driver. All the resistances are of the protected and ventilated type of five minutes rating.

The switchgear consists of a totally enclosed interlocked control panel fitted with a contactor breaker and an overload relay for the main circuit, together with separate time lag relays for each motor circuit. Failure of current, overload or overwind on any motion will open the contactor breaker. The operator brings his controller handle to the "off" position, when the contractor immediately re-sets itself magnetically and without necessitating the operator leaving his control position. A push button switch is mounted within his reach to open the main breaker in an emergency.

Particular attention has been given to the safety and protection of workmen. All the gears are enclosed and the sheaves are provided with efficient guards. Ladders and steel platforms give easy access to all parts of the crane for inspection and maintenance. An indicator is placed in the crane cabin adjacent to the control position to show the relative positions of the jib. Electric cut-outs are provided to limit the movement of the jib, to interrupt the current at the extreme height of lift, and to bring the respective motors to rest by the application of the automatic magnetic brake. At the official test, the speeds attained on the different motions were in accordance with those specified, and the current consumption was in accordance with the guarantee. We may mention that a 5 brake horse-power motor was stipulated for the luffing motion, whereas on test only 4 brake horse-power was required.



JARDINE 3-TON LEVEL LUFFING CRANE

## Cleveland Technical Institute.

THE admirably arranged and equipped Cleveland Technical Institute—at one time the Methodist New Connexion Church in Corporation-road—which has been established at Middlesbrough with the object of extending technical and scientific knowledge, was formally opened on Thursday last by the Hon. Sir Charles Algernon Parsons, K.C.B., F.R.S. The Institute owes its origin chiefly to the efforts of Dr. J. E. Stead, F.R.S., with whom Mr. Jos. Harrison, M. Inst. C.E., M.I. Mech. E., was conspicuously associated in promoting the scheme. The building is centrally situated in the iron town and stands on 1200 square yards. Library, lounge, and reading-rooms, lecture halls, and a preparation laboratory to facilitate the fitting up of any apparatus which may be required for demonstration during lectures are conveniently arranged in the building. The objects of the Institute are :—(1) To encourage and facilitate the continued technical education of staffs and employees of the various industrial works in the district ; (2) to encourage the advancement of metallurgical, mining, engineering, and shipbuilding sciences ; (3) to provide lecture rooms, a technical library, and other facilities ; (4) to arrange lectures for the workmen and the employees engaged in the district on subjects relating to the local industries ; (5) to encourage and to investigate and make known the nature and merits of existing inventions, improvements, processes, and designs which may seem to be of use to the industries of the district ; (6) to publish a bulletin, containing abstracts of all scientific papers and articles which may be of use to the industries of the district ; (7) to join with, or subscribe to, other societies or institutions having like objects, to make grants of money, books, &c., and awards to students ; (8) to use the funds of the Institute in the employment of persons of learning or skill and the provision and use of buildings and of instruments and appliances and any of the equipment of the Institute for any form of scientific study which may be considered to have any bearing, whether immediate or ultimate, upon practical problems involved in the advancement of metallurgical, mining, engineering, and shipbuilding sciences generally in the district.

There was a distinguished gathering at the opening ceremony. Sir Hugh Bell, Bart., C.B., D.L., presided, and said that he was glad they had at last succeeded in bringing to a conclusion a work which had been of the deepest interest to the person whom they all regarded as the only begetter of the Institute—Dr. Stead. He looked back over a long series of years, but failed to remember any one of them in which Dr. Stead was not worrying everybody to do something for the benefit of technology in the district, and especially for the technology of that metal in which they were so deeply interested, and in which there were so many points of interest to all who had to deal either with the scientific or the technical or social side of iron.

What they had now succeeded in doing had nothing to do with technical instruction. It was essentially a post-graduate institution. It was not for pupils, but for those who were engaged in the direction of industry, and who were desirous of perfecting and enlarging their knowledge of the principles. There was no better way in which that could be encouraged than by continuous intercourse such as the Institute would make possible. The Committee did not overlook the fact that all work and no play made Jack a dull boy, and it consequently made provision for recreation. Sir Hugh then touched upon the question of providing a technical college for the district. Those engaged in industry, he said, were prepared to do their part in the provision of such a college; but far from the Institute being in any way a supplement or substitute, it should be looked upon as an additional reason for bringing the college into existence. It made it all the more necessary that there should be a college, and the Institute then became necessary in order to provide for the pupils leaving college in order that they should not forget what had been taught. It must indeed be gratifying to Dr. Stead to think that toward the end of his professional career he had successfully accomplished the work which had lain nearest his heart for many years.

In formally declaring the Institute open, Sir Charles Parsons said he readily accepted the invitation because he was sensible of the very great influence which the advancement of technology had upon the industrial welfare of the country. It was apparent to all that one of the valuable assets of an industrial company was the skill of its staff and workmen, and no doubt that Institute would be the means of making those men more skilled in the work. He congratulated those responsible for directing the policy and establishing the Institute, especially Dr. Stead, to whom they owed a deep debt of gratitude for the conception of the idea of the Institute; for the energy and determination in pursuing the idea; for obtaining the necessary funds, and for guiding the organising committee with wisdom and ability. There was one feature of the Institute that deserved special attention. In their wisdom the founders desired that the Institute should become the home common to members of all technical institutions, or branches of technical institutions, established in Middlesbrough. In accomplishing this task they had done what was universally desirable, and yet was, so far as he was aware, peculiar in this country to Middlesbrough. That scheme gave practical recognition to the fact that each branch of engineering had much in common with all other branches. Thus the building in which the scheme was carried out came to be regarded as the centre of enlightened thought and information in the locality.

## Turbine Blading Failures.

THE following notes, extracted from a paper on "Low Pressure Turbine Blading Failures in Destroyers," by Lieutenant-Commander D. F. Ducey, U.S.N., a member of the American Society of Naval Engineers, concern the machinery of some destroyers built under the War Programme during 1918:—

The main propelling units of each destroyer consist of eight impulse type turbines, these turbines, through reduction gearing, driving the two main shafts with their attached propellers. When operating at full power—about 27,000 horse-power—live steam is admitted to the high pressure turbine steam chest, and after expanding in the first stage, one-sixth of the flow passes through the high pressure turbine, the remaining five-sixths passing to the steam chest of the intermediate pressure turbine. Steam from the high and intermediate pressure turbines expands into the low pressure turbine, and is then discharged to the condenser. The astern turbines, one for each shaft, are fitted in the same casings and on the same shaft as the low pressure ahead turbines, and are capable of driving the vessel astern at a speed of 20 knots.

The low pressure turbines are of the impulse type, having five rows of moving blades. Between rows are diaphragms, in halves, carrying the nozzles. The first and second rows are of monel metal, and the third, fourth and fifth rows are of steel; these blades for some of the vessels being specified of chrome-vanadium steel and for others of chrome-nickel steel. The blades are of the usual impulse type section and of the following lengths:—First stage, 7.281in.; second stage, 9.281in.; third stage, 11.281in.; fourth stage, 12.281in.; fifth stage, 13.781in. The active portion of the blade is approximately 1⅞in. less than the overall length. The low pressure rotor shaft, of forged steel, is 6ft. 3in. between centres of journals. The fifth stage wheel is 66⁷/₁₆in. in diameter over tips of blades; pitch circle, 54in. in diameter. At full power the propellers make about 450 revolutions per minute; the corresponding speed of the low pressure turbine is about 3000 revolutions per minute. The test speed is 25 per cent. in excess of this, and rotor wheels were spun accordingly. All tests were satisfactory.

While stripping turbine blading is not an unheard-of occurrence, it certainly is not a common accident, especially where impulse blading is concerned; and, as a rule, when such an accident does happen, it is usually possible to arrive quickly at a definite conclusion as to the reason therefor. Therefore, in the late summer of 1919, when certain failures of low pressure turbine blading occurred, and there existed much uncertainty as to the causes of these failures, a systematic investigation was undertaken.

The first vessel investigated was the No. 104, which was delivered to the Government on November 11th, 1918. Some time after commissioning, while cruising at 25 knots, a blade, or several blades, in the second stage of the starboard low pressure turbine, carried away. Whether or not the resulting condition was caused by just one blade letting go and tearing the others loose, or several blades going at the same time, could not be ascertained. Shortly after this accident, on August 26th, 1919, while running a full power trial off Newport, R.I., six blades in the second stage of the port low pressure turbine carried away. The turbine was opened, but a careful search for foreign objects did not yield anything, and, as far as could be ascertained, the clearances had been properly adjusted and the operation had not been abnormal. The workmanship was examined, and, while it could have been improved upon, there was nothing apparent that one could say caused the accident. These assumptions being eliminated, certain of the blades were cut up and the metal examined. The examiner's report was to the effect that the metal, in its then present state, was unsuitable for turbine blading. However, while there was no reason to doubt the existence of defective metal in the 104's blades, there were other facts involved that made it advisable to continue the investigation.

As far as could be ascertained, all blades for the 104's low pressure turbines were from the same stock, and were manufactured at the same place and under like conditions; if some few blades failed from weakness of material, it could be expected that all should fail, as like conditions existed. However, the other blades did not fail. Moreover, it was a matter of record that thirty-two exactly similar turbines, like material and like manufacture, had operated over a long period without a single blade failure.

From the data available the following facts were established:—

(*a*) Seventeen of the failures occurred in the port low pressure turbines and five in the starboard low pressure turbines.

(*b*) The greatest number of failures occurred in turbines bladed at a Government turbine plant.

(*c*) The blades for these machines were forged from stock supplied by one of the large steel corporations.

(*d*) Failures in stages were as follows: First stage, 2; second stage, 9; third stage, 7; fourth stage, 2; fifth stage, 2.

(*e*) The primary failure, as far as could be ascertained, involved but one or two blades in a single stage. In instances from one to fifteen blades in a single stage were found stripped, but indications were that the failing of one or two blades was the cause of the others going. In no case was there any indication of a general failing of the blades, the damage usually being confined to the blades being held by a single section of shrouding.

(*f*) Practically all of the blades ruptured across the root section, although in instances where there was a tearing action by the shroud band and loose blades the rupture occurred higher up on the blade.

(*g*) In only one instance did serious vibration exist previous to the blades failing.

(*h*) In certain instances, the fact that blades had stripped was not discovered until some time after the occurrence, when the casings were being lifted for other reasons. In the ensuing interval the turbines operated satisfactorily.

(*i*) In such cases—see (*h*)—while there was no excessive vibration due to the loss of the blades, in those instances where the stripping was discovered at the time of its occurrence, as a rule a very noticeable vibration became evident immediately.

(*j*) Sometimes, when the failure occurred in the earlier stages, the ruptured blade or blades, in going through the following stages, tore blades out of these stages; in other instances the ruptured blade or blades went through as many as three stages and the intervening diaphragm nozzles without tearing loose other blades.

(*k*) Certain blades that failed showed evidence of cracks having existed in the vicinity of the root sections.

(*l*) The root sections were not uniform, they varied between wide limits.

(*m*) In some cases the ruptured blade tore loose from the shroud band; in other instances the blades, even after rupture, failed to tear loose from the shroud band.

(*n*) In no instance was the material of the shroud bands found to be defective.

(*o*) The holes in certain of the shroud bands were not cut true to the centre line, but were staggered.

(*p*) Many of the blades, instead of being true, were slightly bent.

With the above information available, the U.S. Naval Engineering Experiment Station at Annapolis, Md., was directed to undertake an investigation to determine the condition of the metal of the blades and to determine the cause of the repeated failures.

The results of the bend tests on specimens machined from the blades to rectangular section were that in most cases the specimens were bent flat through 180 deg. without signs of failure. Since these tests did not indicate excessive inherent brittleness of the material, bend tests were made on sections of the blades as received, to determine the effect of the blade section shape on the amount of distortion that the specimen will undergo without fracture. A number of blades were bent with the sharp blade edge inward, and others were bent with the sharp edges outward. Those bent with the sharp edges inward were bent flat without cracking, excepting one which was given heat treatment. This one cracked when bent to about 170 deg. The four blades bent with sharp edge outward showed cracks in every case long before bending to 180 deg. In one case the angle of bend was only about 45 deg.

The bend tests on the blade material show that apparently in most cases the standard machined specimens could be bent through 180 deg. without signs of fracture. In some cases, failure after bending through approximately 180 deg. occurs. This shows that in general the material cannot be considered excessively brittle, although under certain conditions a slight tendency toward brittleness is indicated.

The bend tests on the blades as received, and the bend experiments on different shapes, throw light on the entire problem. It is a well-known fact that in a stressed bar containing a sudden change in cross section, the distribution of stress is not uniform in the section where the change occurs. Under some conditions, the maximum stress may amount to considerably more than the average stress in that section. The design of this type of turbine blade is such that a sudden change of section occurs between the root and the blade body. This section is the one of maximum bending moment and the maximum stress under bending would be considerably greater even than the theoretical stress. The shape of the blade section itself is very poorly suited to resisting bending loads without cracking. The sharp edges of the section are the points farthest removed from the neutral axis, and therefore subjected to the greatest stress when the blade is bent. The bend experiments show that such a section, when bent with the sharp edges outward, will crack much more readily than one of rectangular shape. Thus, specimens having a rectangular section bent completely through 180 deg. without cracking, excepting one of Class "Ac" steel, which just cracked at 180 deg. A re-test of this specimen showed no crack. Specimens with rectangular section, but bent at a sudden change of section, also bent through 180 deg., excepting the "Ac" steel specimen, which broke at 90 deg. The specimens of turbine blade shape show cracks in every case. Those with the sudden change of section crack much sooner than those of uniform section.

The great variation in the chemical analysis of the blades indicates in many cases a wide departure from the A.S.T.M. specifications for chrome-nickel steels. The preponderance of chromium over nickel found in the blades containing over 1 per cent. Cr and about 0.5 per cent. Ni is an unusual combination.

It is well recognised that the forging of chrome-nickel steel must be carried on with great care to prevent the formation of fine surface cracks. Such cracks might easily be overlooked, and in turbine blades would develop rapidly, due to the fatigue stresses caused by vibration of the blades in service. The question of vibration in turbines, causing fatigue failures of blades, has been given considerable attention, and many turbine failures have been attributed solely to that cause. The results of investigations at the experiment station have shown definitely that under certain conditions, fatigue failures may be caused by stresses in the neighbourhood of half the elastic limit of the metal as determined by static tests.

### CONCLUSIONS.

Results of the chemical analysis of damaged blades from the 175 show these to be of chrome-nickel vanadium steel of the general composition Cr 1.25, Ni 0.40, Van 0.20. The composition of the spare blade from the 175 indicates Cr 0.70, Ni 3¼, Van none. The blades from the 178 are of the same composition as the 175 spare blade. The composition of the blades from the 280 varies, including both of the above types.

The metallographic examination showed considerable variation of structures typical of this grade of metal. In most cases the structure is quite satisfactory. In a number of cases the structure gives evidence of rapid cooling, possibly followed by annealing. In other cases segregation of constituents was shown. In a few cases wide variations of structure between different parts of the same blade indicated lack of suitable annealing. However, nothing about the microstructure was considered sufficiently unusual to justify attributing the failures entirely to faulty metal.

The results of various heat treatment, impact shear, and bend tests show that while in most cases this material is quite ductile, in some cases a slight brittleness in the metal was observed. Under the worst conditions, however, the metal cannot be considered excessively brittle.

The results of the special bend experiments on specimens of various shapes when studied in connection with information given regarding the difficulties encountered in blading these turbines, indicate with little doubt the cause of the whole trouble. The design of this type of turbine blade is such that it is very poorly fitted for undergoing plastic deformation when bent, without the formation of cracks at the junction of root and blade. While this is true even when the metal itself is very ductile, it is particularly true when there is a tendency to brittleness in the material due to faulty microstructure, or to other causes. In bending the blades to make them fit into the shrouding, a number of the blades cracked completely. Undoubtedly many other blades were only cracked slightly, and these cracks passed unnoticed. Under the influence of service fatigue stresses, such cracks would rapidly develop, ultimately causing complete failure of the blade, and stripping of the entire stage.

Attention is invited to the following:—

(*a*) In specifying the raw material, consideration must be given to effect that subsequent forging will have on the material.

(*b*) Heat treatment, at whatever stage or stages it should take place, must be carefully watched.

(*c*) A final heat treatment that will ensure uniformity should be given the blades.

(*d*) Each and every blade must be true to designed shape; otherwise, in attempting to install, deformation of blade will take place.

(*e*) Under no circumstances should a bent blade be installed, nor should deformation of a blade, in order to make it fit, be attempted.

(*f*) The shroud band holes must be true with the tips of the blades, and to ensure this, after the blading is installed, a template should be made and from this the holes in the shroud band should be located.

(*g*) Every blade should be examined minutely, preferably with a glass, especially at the edges and around the root section, for cracks; if cracks are discernible, the blade should be scrapped.

(*h*) The blades in question can be strengthened against cracking to some extent by allowing a larger fillet between the junction of the blade and the root and widening the sharp edges of the blade at the approaches to the root. Such, however, while it may tend to counteract defective workmanship, will not eliminate the possibility of failure due to deformation.

(*i*) Blades of good material, improperly manufactured and mishandled during installation, are more likely to fail than blades of an inferior grade of material, properly manufactured and properly installed.

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THE Swiss Railway Administration has ordered several types of single-phase locomotives to suit the various traffic and route conditions. Some of these are quite large and powerful machines, weighing up to 128 metric tons. The maximum adhesive weight in the largest is 104 tons, which may give as much as 24 tons d.aw-bar pull at starting and 17 tons for the full load tractive effort on a 1½ hour rating. This particular type is intended for working goods trains with a load of 860 tons. With a train load of 300 tons, the locomotives are capable of a maximum speed of 40 miles per hour on gradients of 1 in 100, so that they can be used for passenger traffic on mountain lines. They can develop 2200 horse-power for 1½ hours and more for short periods. Each of these locomotives is composed of two units, each with three driving axles, two motors and one transformer. They are designed for regenerative braking.

## Oil Burning at Sea.

By A. KEENS.*

To get the best results from oil fuel requires a certain amount of experience and thought. Oil fuel may be burnt in such a manner that combustion is, to our present ideas, perfect, and without a sign of smoke. On the other hand, the smoke may be so dense and black as to leave a trail in the sky extending for several miles behind the ship. In certain cases of converted ships, the elimination of smoke has presented quite a difficult and insurmountable condition, even to the minds of engineers thoroughly experienced and conversant with oil burning. From experience it would seem that unsatisfactory combustion and consequent black smoke may arise from a great variety of causes, and is not cured so easily or simply as some authors of books would give us to understand. It has been found that providing the boilers and fittings are satisfactory the burning of the average oil fuel usually supplied may be carried out with entire satisfaction at a temperature of about 200 deg. Fah.; an oil pressure of from 15 lb. to 40 lb. usually being necessary to give smokeless combustion. These conditions do not, of course, meet every case, and it is a matter of experience to hit upon the correct combination of conditions quickly, for there is great variation. With particularly dense oils it has been found that an oil temperature of 300 deg. to 350 deg. Fah. and a pressure of 70 lb. or thereabouts is required to burn them efficiently. In isolated cases, in tropical climates, and using solar oil fuel, it has not been found necessary to heat the oil at all; the oil at a temperature of about 90 deg. Fah. giving satisfactory results.

The pressure is governed, or should be governed, by allowing the smallest amount of oil into the furnaces that will maintain the full boiler pressure and prevent the oil dropping and collecting in the furnace bottoms. Any collection of oil in the furnace bottoms must be strictly avoided, for it is a cause of serious danger. It is caused by the combination of temperature and pressure not being correct, or it may be caused by dirty burners.

### SMOKE.

Black smoke may be caused in a variety of ways, an insufficient quantity of air admitted to the furnaces being a very common cause; too much air being admitted at the bottom of the furnace may cause it. The best place for admitting the air appears to be directly behind the burners. Unsatisfactory pressures and temperatures may be the cause. If forced draught is used, the pressure may be too low, or the pressure may be too high with the fault of having a too contracted air vent area. Should the boilers develop black smoke after running satisfactorily for some time, and all other factors remain the same, this indicates invariably that the back ends are leaky. In some cases the boiler construction may be a contributory cause, and whilst it would be impossible to enumerate all the causes, the reasons given above are the most prevalent.

White smoke is not nearly so common as the previous fault, and is caused by an excessive amount of air being admitted to the furnaces. This condition should be particularly avoided, for the consumption of oil fuel increases rapidly under it. It should be borne in mind, however, that absolutely smokeless combustion need not necessarily mean the most economical condition; a slight haze is preferable.

Should boilers pant when under action, it is an indication that there is not a sufficient quantity of air being admitted to the furnaces. When lighting up cold boilers, smokeless combustion must not be expected, but when the boilers get thoroughly warmed up, if the combination of pressures (oil and fan) and temperatures are correct, almost smokeless combustion is the result. After the boilers have been shut off for some little time, there is often an accumulation of gas in the furnaces and combustion chambers that is of a very explosive nature; therefore, before introducing a torch into the furnaces for lighting up purposes, it is imperative that the air vents should be opened first to blow out the gases; also, it is extremely dangerous, under certain conditions, to turn on the oil first and then afterwards apply the torch.

### LIGHTING UP.

In all cases when lighting up, the actions must be in the following rotation: first, air vents to be opened; secondly, introduce the torch; then turn on the oil. More engineers have been badly burnt through the non-observance of this routine than from any other cause, and when one considers that an explosion of the severity of 200 lb. per square inch may result from such an action, it is surprising that really severe accidents are so rare. In ships where oil fuel is permanently burnt, the funnel damper is invariably omitted, whereas the ships that are fitted for quick converting still retain the funnel damper. In such cases it is advisable to lock it in the open position so that it cannot be accidentally closed; severe explosions similar to the kind quoted in the last paragraph are sometimes traceable to a shut funnel damper.

### AIR LEAKS.

With oil fuel, the workmanship of the boilers and fittings should be of the best, and all air that is present in the funnel should have entered by the furnaces; particular care should be taken with the smoke-boxes and base of the funnel to make them as air-tight as possible. The exclusion of air from the smoke-boxes and funnel base is of far more importance than the average engineer seems to realise. With forced draught the same applies, and it is of the utmost importance that the forced draught tubes and casings in the base of the funnel should be tested periodically and maintained in a perfectly air-tight condition. Should air leak into the smoke-boxes it will combine with any unconsumed gases that may be present, and if the gases are at a sufficiently high temperature, spontaneous combustion is the result, and the air casings and tubes, top of the smoke-box doors, and the base of the funnel assume a red heat. In many cases the air tubes are burnt out and the tube plate badly buckled. When using oil fuel the slow fouling of the boiler tubes is a noticeable feature. If, however, the boiler tubes should foul rapidly and require sweeping at short intervals, it is an indication that air is finding its way into the smoke-boxes, and a thorough examination should be made to locate the faults.

A case is on record where it was necessary to sweep tubes every twenty-four hours owing to excessive air leaks into the smoke-boxes. Never in any circumstances neglect to clean burners that are spraying badly. If left even for a short time the entire burner may become so badly carbonised as to be ruined. Badly spraying burners are also a fruitful cause of fires owing to the oil collecting in the furnace bottoms and running down the boiler fronts. Cleanliness in the stokehold is a virtue, and special attention must be paid to the cleanliness of the platforms and tank tops, and no oil leaks, however slight, must be permitted. In the interests of safety there should be two large and several small chemical fire extinguishers fitted so as to be ready in case of accidents.

When at any time it is necessary to shut off the oil from the boilers, special care should be taken to prevent any air from finding its way into the furnaces and combustion chambers, and all sudden changes of temperature should be avoided. Too much exertion cannot be used in the closing of dampers and air ducts, &c., after shutting off the oil fuel; neglect and sluggish action in this particular soon makes itself apparent in the shape of leaky seams, rivets and tubes. Always keep a close watch on the sight feed tank, or the observation tank as it is usually termed, for evidence of oil leaks in the heating system and coils. A leaky system not only means that the oil may be finding its way into the boilers, but also that the water is finding its way into the oil. When using thick fuel oil it is advisable, after shutting off the fires and heaters, to keep the oil pumps running for some time in order to circulate the oil round and round the system until it assumes a normal temperature. Should the pumps be stopped at once, and the oil left hot and stagnant in the pipes and heaters, it deposits a pitch-like substance on the interior surfaces when cooling down, and the entire system is in danger of becoming choked.

Should the pressure of steam fall, and everything else remain normal, it is not wise to force up the steam pressure by increasing the oil pressure; search for a cause. In all probability it will be found that some of the burners are partly choked and require attention. Forcing up the oil pressures increases the combustion chamber temperatures above the normal for a particular pressure of steam. In all cases the oil pressures must be kept as low as possible consistent with satisfactory combustion, and when lighting up cold boilers, careful air regulation is necessary; with forced draught 1in. on the hydrostatic gauge is quite enough.

When burning oil fuel, it is advisable to let the oil flare as near to the burner end as possible, without unduly heating the furnace fronts; this ensures a comparatively even temperature throughout the entire length of the furnace, and reduces combustion chamber temperatures. Within reason, it is advisable to confine combustion to the furnaces as far as possible; with this idea in view it is, in certain cases, advisable to increase the forced draught air vent area; this allows a certain amount of latitude for experimenting purposes. By increasing the vent area it is possible to supply the same amount of air, or perhaps more, at a reduced pressure.

* From a paper read at the Institute of Marine Engineers, September 6th.

## Provincial Letters.

### THE MIDLANDS AND STAFFORDSHIRE.

(*From our own Correspondent.*)

#### Trade and Goverament.

IMMENSE interest has been excited this week by the Government proposals with respect to relieving unemployment and especialy to their alleged intentions in the matter of assisting trade back to something like a normal condition. The Chancellor of the Exchequer is understood to have declared that this last problem is essentially one of credits. In the course of a conversation which he has just granted to an interviewer, Sir Robert Horne is represented as having said that "he could with £100,000,000 real credit revive markets and trade, and the greatest factor in unemployment would then disappear." The Chancellor is further alleged to have added that it is significant that the largest figure among the trade unions furnishing unemployed figures for August is that of the engineering trades—well over 200,000. "These men cannot be helped by road building. What they want is trade, and trade wants markets." Commenting on the foregoing, iron and steel masters in Birmingham and Staffordshire are asking this week whether it is possible to finance a trade revival. They have their doubts about the matter, and these are in many directions serious. To some little extent, however, it is declared to be encouraging that the Chancellor should have mentioned the example of Guest, Keen and Nettlefolds in offering to run their Dowlais works at a loss to provide work, and should have also said that he knew of another firm that was prepared to lose half a million to keep men on.

#### Will Staffordshire Common Bars Fall?

As I was able to announce in the Latest News columns of THE ENGINEER last week, there has been a reduction in the price of Lancashire common bar iron of £2 per ton, for delivery in the Lancashire area. Since then the reduction has also been joined in by the Scotch ironmasters. Although it was felt here that ironmasters in this district would, as they have previously done, follow this lead, the Staffordshire and South Yorkshire ironmasters both decline to reduce their prices, and bars in Birmingham are still sold at £16, in conformity with Association prices. Through the divergent views of millowners in the various districts on the subject of deflation, therefore, a complicated position has arisen. There has been for some time an impatient feeling among Lancashire makers over the contrast between foreign and home prices, and as it was found impossible to get general agreement to a further reduction in the English and Scotch centres of the trade the Lancashire Association exercised the right which it has under the Federation constitution to act independently. Staffordshire makers, to whom the proposal was submitted before action was taken, declined to have anything to do with the movement. They regarded it as ill-timed and as affording no promise whatever of stimulating buying. This view they still adhere to, and it is shared by the Yorkshire makers. The effect, however, has been to check business in Birmingham, and consumers still anticipate a lowering of prices here. Isolated mills and forges are doing a little work for customers who regard Staffordshire iron as the essential raw material of their manufactures. The demand for the nut and bolt and fencing trades remains very poor, and another matter which is likely to hasten an adjustment in prices is the fact that Belgian No. 3 iron can be purchased at £9 5s. delivered here. Some of this continental iron, it is stated, has not been satisfactory recently, and shippers are now selling on the terms of net cash seven days after delivery, which will give buyers an opportunity of satisfying themselves as to the quality of the material. The marked bar houses continue to be fairly well employed with orders sufficient to keep them in operation.

#### Next Week's Quarterly Meeting.

The Midland ironmasters' quarterly meeting is to be held next week, October 6th, in Birmingham, one week in advance of the usual date on account of the holding of the Church Congress in Birmingham. The question of the price of bar iron is sure to form a subject for discussion. The Staffordshire iron trade at the present moment appears to be the most unfortunate department, and the quoted price of £16 for finished iron is, in spite of the reduction in other districts, regarded by ironmasters here as completely uneconomic. There is a lack of activity in iron strip market, even at the reduced figure of £17 10s. Moreover, manufacturers state that this again is unremunerative. There is a good deal of idle plant in the district, and steel strip at £12 is still holding sway with the tube makers. Here and there, however, a tube maker is using iron on account of its superior resistance to corrosion. The galvanised sheet department is in a better position, and sheet mills operating in the district manage to get sufficient orders. Business appears to be broadening a little, and prices remain firm. Some good sales recently have got rid of a certain amount of stock.

#### No Call for Pig Iron.

Little headway is being made with the re-starting of blast-furnaces in the Midlands, though this week two of the five blast-furnaces at the Spring Vale works of Alfred Hickman, Limited, have been blown in. This operation was intended originally to have taken place on September 14th, but there has been a certain amount of delay in regard to the delivery of necessary materials, notably coke. Those furnace owners who have re-started have received very little encouragement, and one large concern, which was among the earliest to get into operation in the Derbyshire district, is reported to be putting into stock quite three-fourths of its production. It is stated that buyers cannot be found for Derbyshire forge iron at 110s. at furnaces. A weakening tendency is observable in regard to foundry numbers, for which there is very little demand. There are, however, no quotable changes. Those furnaces producing forge iron are in a bad way. The stagnation in the engineering trade is accountable for a good deal of idleness at the foundries. While a little business is being done, orders seldom exceed a truckload, consumers being quite satisfied that further reductions are pending. There is more cheap foreign pig iron coming in, some of it at very low prices. This offers a formidable menace to the makers of pig iron here, and helps to discourage the re-lighting of furnaces. Smelters continue to be discouraged by the continued high price of fuel. The lowest price quoted continues to be £1 2s. 6d. at ovens, and the owners of some Staffordshire furnaces consider that on this basis the cost on arrival would be about 35s. per ton. A waiting policy is therefore adhered to for the present.

#### Belgium Drops Out.

The large influx of Belgian steel has disappeared with some suddenness after a remarkable run of profitable business in this country. British steelmakers, in making drastic price reductions, have left no cause for manufacturers to buy foreign steel, and with British quotations on a level with their own the foreigners are not now seeking business. Indeed, they are having their contracts cancelled through failure to make delivery. One such contract amounted to 2000 tons, which the buyer in this country was rather glad to cancel, since he could purchase more satisfactorily from British works. There is a good deal of cheap French and Belgian pig iron coming in. This offers a great advantage to local steelmakers, and to some extent accounts for the progress made in getting the steel works into operation again. It is helpful in enabling the manufacturer to compete for home and international orders on a rather favourable footing. Surprise has been occasioned by the reappearance after an interval of some months of American steel at prices well below British figures. Though the amount is not great, it was unexpected in view of the unfavourable rate of exchange.

#### Midland Miners and the Coal Subsidy.

Those concerned with the North Warwickshire coalfield can afford to look with complacency to the close, at the end of this month, of the temporary period under the settlement of last July. The explanation of this complacency is that, as it has not benefited by the Government subvention of £10,000,000, it has nothing to lose when the period for which it was available comes to an end. The Cannock Chase coalfield will also be unaffected. That is is not to say there will be no reduction in wages, for the probability is that the wages for October will show a reduction. It is not expected to be a large one, but in any event it will have nothing to do with the exhaustion of the subsidy. This district has been specially fortunate in escaping the wages reductions that miners in some parts

of the country have had to suffer. Instead of reductions of 2s., 2s. 6d. and 3s., they have only lost 1s. 5d., 1s. 5d. and 1s. 1½d. The South Staffordshire and East Worcestershire coalfields are not in the same happy position. Owing to the condition of the mines in these areas the financial assistance of the Government has been found to be necessary. The profits of the industry have been so small that, it is stated, there is no instance in the whole of the area where Government aid has not been sought. Considered either from the point of view of the owners or from that of the miners, the situation which will present itself at the beginning of October is likely to be one of some difficulty. It is calculated that with the withdrawal of the subsidy, the mining industry in the Shropshire, East Worcestershire, and South Staffordshire districts will yield but a very small profit, and the difficulty arises when assessment of this profit is brought into relation with the prospective earnings of the miners.

**Trade in Coventry.**

Coventry's industries are quieter than they have been for some time, and very little new business is coming through. Owing to the exceedingly high cost of production, firms which hitherto have been able to dispose of a certain amount of their output are finding that they are accumulating stock. Until manufacturers are in a position to reduce their quotations there is little prospect, it is said, of any business of magnitude being carried through. It is urged that something really substantial in the way of wages reductions has to be brought about before Coventry can hope to compete with the world's markets. There can be no hope of improvement, said a manufacturer, until the men themselves realise the true position.

**North Staffordshire Trade.**

Trade in North Staffordshire in general is in a fairly flourishing condition, and many manufacturers have sufficient orders on their books to carry them on right through the winter. The unemployed in the pottery trade is only about 6 per cent. The most serious position is in the iron and steel and coal trades. The miners are mostly only working three or four shifts a week. Several hundred men employed by the Shelton Iron, Steel and Coal Company ceased work last week-end. Only one of the rolling mills is being worked, the others being closed down through lack of orders, while the steel furnaces are idle. The blast-furnaces are at present in operation. A number of ironworkers in the district have been continuously unemployed for as long as thirty weeks. Reports from the engineering firms show that trade in their department is very moderate.

**Unemployment and its Causes.**

At a divisional committee meeting of the Iron and Steel Trades Confederation, held at West Bromwich on the 24th inst., a sub-committee reported having considered the question of unemployment, and recommended that there should be a deduction of 1½ per cent. from all earnings over £2, but, in view of the smallness of the replies received from the branches, it was decided to hold the scheme in abeyance. The chairman, Mr. Groves (Round Oak) regretted that the scheme had fallen through, because, he said, it was up to all those who were in work to assist their less fortunate colleagues who were out of work. Mr. John Hodge, in proposing a resolution in favour of co-ordination in the trade union movement, said that the Iron and Steel Trades Confederation had suffered ever since the Armistice because of the lack of ability among employers of men in other trades to come to satisfactory arrangements as they (the iron and steel trades) had done, though he did not see anything to prevent it. They had a system that had been of incalculable benefit to the whole of the men in the trade. The trade unions said they believed in a fighting policy, but their own organisation had never needed to fight, and they had been saved the necessity of hard blows. One thing, he said, which helped unemployment more than all the Bolshevik oratory in the world was the 12½ per cent. in wages given by Mr. Churchill, which no one asked for and everybody tried to get. It was calculated to have cost the country £500,000,000.

**The Engineering Crisis.**

The crisis which has arisen in the engineering industry as the result of the demand by the employers for the withdrawal of the Ministry of Munitions bonus has created serious fears in engineering circles in the Midlands and business is to some extent being held up pending the outcome. The seriousness of the disastrous consequences of a stoppage are realised in Birmingham, where it is held that every possible step should be taken without delay to seek a solution. Master engineers in the Birmingham and Coventry districts are earnestly hoping that the proposal made to seek the assistance of the Minister of Labour will be readily acted upon, and that he may be able to suggest a way out of the deadlock.

## LANCASHIRE.

*(From our own Correspondents.)*

MANCHESTER, Thursday.

**Iron, Steel and Metals.**

THERE are perhaps some signs of improvement in the markets, although they are doubtful, and may quite probably be the result only of individual experience. There is, of course, always a certain amount of business passing, and when one merchant gets more than his share, he is apt to believe that his experience is general, and that there is an increase in the demand. The chances are, however, that we have still a long period of minor fluctuations to go through before industry generally can be re-established on firm foundations.

**Metals.**

The position in the market for non-ferrous metals is not much altered, and speculators seem rather tired of waiting for an upward movement which, although fully due, is delayed for so long a time. The prices for standard and refined copper have scarcely been altered, and the demand remains very poor. As your readers know, Germany has for some time been one of the principal buyers of copper in Europe, and it is now said that the further collapse of her exchanges will check further purchases and may even lead to re-sales. One is, however, inclined to think that this apprehension is not too well-founded. Germany needs the metal if the revival in her industrial condition is to continue, and no doubt she will find a way to obtain it, unless, of course, that revival is to come to an end. Very few signs of large buying of copper are yet visible in the general engineering trade of this country, and the brass trade, which usually consumes a large amount, is very dull. The very large accumulations of scrap brass interfere considerably with the need for new brass, and it is probably true that the demand which should come for brass tubes is delayed by unnecessarily high prices. During last week the official quotation for brazed brass tubes was reduced by ½d. per lb., but it remains at 1s. 3d. per lb., or ½d. per lb. more than the price of brazed or solid-drawn copper tubes, and one cannot comprehend why a consumer should buy at such a price. Best selected copper ingots remain at a comparatively low price, and while this is the case one cannot see how any revival in the demand for copper can be taking place. The market for tin is very steady, and the prospects are perhaps better than they have been for some time. Both in South Wales and in America there is some activity in the tin-plate trade; and in the former district more works are getting into operation. This being the case, the consumption of tin ought to improve during the next few months, and with such improvement there should be an access of strength, because the price at the present time is not at all excessive, and not greatly above an ordinary pre-war level. Lead has remained fairly steady, and there has been considerable buying recently on the Exchange; but it is not clear that this is connected with any improvement in the consumptive demand. There were some very tired "bears" who have been waiting for the collapse until their nerves gave way, and this may account for the greater amount of buying. Spelter has been a little better, but people are rather nervous as to what Germany may do now that the exchange is so low.

**Pig Iron.**

The same lack of demand for all classes of pig iron other than foundry is still in evidence here, and it is obvious that makers are nervous as to what they are to do with No. 4 forge and white pig iron. Apparently, they cannot clear their stocks, and, of course, some of these lower grades are constantly being made. For foundry iron the demand here is not too good, and apparently the tendency to buy from hand to mouth is increasing. Consumers seem to have convinced themselves that there is no probability of foundry iron becoming dearer for a long time, and with this conviction there is a natural determination to keep the stocks as low as possible. Furnace owners admit that their orders come to them in truckloads for prompt dispatch, and there is no opportunity to make far-reaching contracts. This is very awkward for a furnace proprietor, because he never knows when he will be compelled to make iron for stock, and this is a dangerous method of working in these times. Cleveland iron is offered here at a delivered price of £7, and if bought direct from the furnace on furnace terms would cost a little less. Derbyshire iron, delivered in Manchester, is quoted still at £7 5s., but might perhaps be bought at £7, if a buyer were willing to make a contract for a substantial quantity. Scotch iron remains both scarce and dear, and there is only a small demand for it here at the present cost.

**Finished Material.**

There is not much stirring in the market for finished iron and steel, and what this market needs to give it a fillip is a revival in shipbuilding. That this can come within any short time is exceedingly improbable. The condition which prevents the building of houses is also that which prevents the building of ships, viz., that they cannot be built at a cost which will enable them to pay a profit. The only favourable feature in the market for finished material is the improvement in the continental prices. Not so very long ago, for instance, there was a gap of £7 to £8 per ton between British and continental bar iron. This gap has now been reduced to £4 or £5. Of course, it is much too great yet, but there is some hope that it may eventually become reasonable and represent merely the difference in quality.

**Scrap.**

The demand for heavy wrought and steel scrap is still practically in abeyance, but there is now some chance that it may revive again. Foundry scrap can still be sold here at from £5 10s. to £6 5s. for good ordinary and for machinery qualities. There is, moreover, still a demand for fine "textile" scrap to take the place of Scotch iron, and up to £7 5s. is asked for this class of metal.

**The College of Technology.**

For the forthcoming session at the Manchester Municipal College of Technology the usual part-time day courses in mechanical and electrical engineering have been arranged. Admission to these courses of lectures is restricted to a limited number of students who are able to produce evidence of exemplary character and of special ability. Candidates who cannot produce such evidence are required to pass an examination in mathematics, mechanics, &c., and must present a certificate in engineering drawing. The courses involve attendance on one day a week—Monday—throughout two sessions of about forty weeks each, and cover approximately the same ground as that covered by the final three years of the evening Associateship Course in Mechanical and Electrical Engineering. The part-time day course thus forms an alternative advanced course, leading to the associateship of the College and to the Advanced Course Certificate. But students who attend the part-time day course have considerable advantage over students in attendance at evening classes; for the former have more leisure for the essential private study, and, coming fresh to their lectures and laboratory work in the College, are in a position to derive greater benefit from their course. A comparison of the part-time day course with the evening advanced course will, however, show that the latter provides several alternatives that are not provided by the former. Students who have completed a part-time day course may supplement it at their leisure, and without payment of fee, by attending evening lectures. The arrangements between the College and a number of engineering firms in the Manchester district, whereby selected men or women employed by these firms are allowed to attend the part-time day course, include provision for monthly reports to the firms on the attendance and progress of their employees, and in certain cases for the immediate notification of students' absences. The administration of the College makes itself responsible to the co-operating firms for seeing that their employees attend regularly and work satisfactorily.

BARROW-IN-FURNESS, Thursday.

**Hematites.**

There is again more activity to report in the hematite pig iron trade from an industrial point of view. Following the furnace put into operation at the Barrow Ironworks last week, a second furnace was got to work on Monday. When the slump set in in the spring, five furnaces were operating at Barrow. At the Ulverston Ironworks a second furnace has been started, and now the whole of the plant is working and the men are on full time. The demand for iron is still quiet, and there cannot be a full resumption till such time as smelters can offer buyers much more attractive terms. The tendency is all in the direction of reduced prices, but there are difficulties yet to be settled before the trade can get down to anything like normal conditions.

**Iron Ore.**

There is more activity in the raising of hematite iron ore so far as Cumberland is concerned, where the miners accepted the cut in wages. Several pits have been opened on short time. In Furness the miners, in face of advice from their executive, declined to accept a temporary cut of 10 per cent. in wages. A fair amount of ore only is being raised in the Furness mines, and whether or not the decision of the men will retard further progress is not certain. On the other hand, more men were started at Roanhead on Monday last. The importations of foreign ore into Barrow have started again.

**Steel.**

In the steel trade there is activity at Workington in the rail mills and other departments, and next week there will again be some work in the steel departments at Barrow when the producing plant will be restarted and some of the mills set going. The hoop mills are pretty busily employed, and have been for the past few weeks. The foundries are also engaged. Steel generally is in limited demand.

**Shipbuilding and Engineering.**

After the Cunard liner Antonia was launched in April last, all work on her was suspended on account of the high cost of production, but the embargo has been removed, and work has been restarted. The boilermakers are again at work, after a brief strike. The engineering shops are on short time.

## SHEFFIELD.

*(From our own Correspondent.)*

**The Storm is Abating.**

LEADING manufacturers in the steel trade are watching the situation very anxiously indeed, but there still seems no reason for revising the view expressed in previous letters that the worst of the slump has been experienced. If there is one thing more than another giving cause for anxiety it is the way in which important firms are, in a sense, "leaning up against each other," as one well-known director put it to me. That is to say, they can pay their way all right, though living almost from hand to mouth, so long as in their circle of business connections there are no defaulters. Should anything really serious occur in the way of the latter it is not impossible there may be grave trouble. As it is, one constantly hears rumours of one kind and another—at times very unpleasant and disturbing rumours—but happily they seem to originate from nothing more substantial than commercial nervousness. Everyone knows the dangers that threaten, and occasionally someone takes fright unnecessarily, and so becomes responsible for the rumours referred to. It would be well if such tendencies were carefully guarded against. The times are exceedingly trying, but there are plain indications that the storm is abating, and it must be a source of very great gratification that with few exceptions manufacturers in this part of the country have so far safely ridden it through. At this moment it is more than ever needful that as optimistic a view of the situation as possible should be taken. Pessimism may be difficult to fight against, but to give way to it now is a sign of weakness; while to lend an ear to ugly but groundless rumours, which are no sooner in circulation here than they find their way to America and other countries with which we are in keen competition, may be doing Sheffield's credit a very bad turn indeed.

**Demand Brightening Up.**

The chief trouble at the moment appears to be the very slow recovery in our export business—principally from causes discussed in recent letters—and the manner in which our iron and steel makers are being undercut by the Continent. In both those cases, however, there seems ground for believing that a change for the better is

approaching. The extraordinarily low rates at which Belgian and German pig iron and steel billets have been offered delivered on this side of the Channel have, to a large extent, been made possible by a throat-cutting competition between those two countries, and that kind of rivalry seems to be wearing itself down. With dead soft basic steel made in the Sheffield district down to as low as £8 a ton, the margin between the home and foreign material is now comparatively narrow and not, perhaps, worth consideration by some firms, for consumers here have to buy whatever continental material they require on the terms of "a pig in a poke," accepting whatever may be sent, while in the case of home-produced material that is not so, and they are always sure of stuff superior to that of foreign make. I am told that no surprise would be felt if the next price movement for continental iron and steel were in an upward direction. Certainly cases are occurring here in which it is exceedingly difficult to get delivery of certain classes of manufactured steel from Germany or Belgium, whereas in some directions the home demand is distinctly brightening up, and even railway companies are beginning to place orders a little more freely. The prospects for an appreciable resumption of work on new liners, too, are looking brighter, and should things develop in that direction, some of the Sheffield works would stand to benefit. The great difficulty, of course, is that the output capacity of the whole district is actually so much larger than in pre-war days that orders which might then have seemed quite good are now altogether inadequate to maintain even an appearance of activity.

### Talk of Ending the "Rings."

I have just seen a very nice little inquiry for spring and polished octagonal steel for India, with every prospect of it being "landed," and I hear there are a good many other inquiries coming in from overseas. One interesting fact is that considerable business has been placed in Sheffield lately for a description of cheap knife or cutter, used, I believe, for cutting raw cotton. Some years before the war this trade was cultivated, but eventually left the district as being hardly worth Sheffield firms' consideration, and went to Germany and America. Now, with trade slack, manufacturers are glad to take it up again, and I hear that quite large orders are in hand for South America and India. One firm here is busy producing steel beds for paper-making machinery. Some of the smaller firms appear to be picking up new business faster than the larger ones, and quite a volume of inquiries from the Colonies and South America for crucible, mining and other steels has lately materialised into orders, with the result that one finds not a few of these smaller works really busy amid the general gloom. This condition of things has given rise to the belief, in some quarters, that the days of the big "rings" are numbered, and the feeling that if they were free to quote as they liked many members of these "rings" would quote lower than is the case at present, with the probable result that business would be secured which is passing them in favour of foreign rivals. What seems possible is that before we are clear of the prevailing bad trade both manufacturers' "rings" and the men's trade unions will have to do a little climbing down—at least, they may have to revise their ideas. No great improvement will come without radical changes to meet the extraordinary industrial and commercial situation, and those may be two of them.

### Hopes for Oversea Markets.

With the return of rather better financial conditions in countries like Brazil, keen attention is being directed on the South American markets, from which the United States manufacturers are endeavouring to drive German rivals. The standing of the latter seems none too good, for Germany appears to have been committing herself commercially beyond her powers of fulfilment. Before the war, however, these were very valuable markets for Sheffield manufacturers, and whatever hopes the United States may have of capturing new business there, it is plain that a strong bias still exists in South America toward trade with Britain. At the moment, the chief difficulty appears to be the need for longer credits than Sheffield firms are able to arrange, but even in face of that serious drawback there is no doubt that Sheffield is gradually regaining some of its old trade. Rather more business, too, is being done with certain parts of Russia, though manufacturers here fear it will be a good time yet before any appreciable advance can be made into those markets, for there is no spare cash to risk on speculative trade. As I mentioned in last week's letter, several steel-melting furnaces have recently been re-started, but the majority are still idle, and in the North Lincolnshire district, where of late years many millions sterling have been spent in the development of iron and steel-making plants, scarcely anything is moving, though hopes are entertained of an improvement soon. The season for land implements and tools has not been a bad one, but buying is now of only a desultory kind, and regarding other small tools and saws, American exports are competing rather keenly for whatever business offers. The crucible department, with a few notable exceptions, continues very flat, but the steel trade generally is anticipating better markets in the Far East, as well as Australia, South Africa and France, where loans are being raised with the definite object of repair or development work in the direction of railways, bridges, roads and harbours.

### A Rail Jointing Invention.

Two or three exceedingly interesting inventions have been brought out recently by Sheffield men, and to one of them I would like to refer now, leaving the other two for future discussion. It relates to a new method of securing the joints of tramway rails. Instead of using 18in. fish-plates, bolting them, and afterwards welding the actual joint, as usual, fish-plates of 14in. only are fitted tightly between the web and flange of the rail, one being placed on either face of the rail and forced into close contact with it by powerful clamps, which hold it in position until the edges can be welded. The plate is welded to the rail top and bottom, a sole plate fixed underneath supporting the joint and giving it a strong foundation. It is the invention of Alderman H. Bolton, of the Sheffield Corporation, and the city tramways undertaking is just now submitting it to some severe tests, the results so far being entirely favourable to the new system when applied to actual tramway work. When submitted to the "tup" test, which usually cuts a joint at the first blow, it was undamaged after four impacts. At the next blow, when the falling distance was doubled, the rail broke on one side of the joint and the flange on the other, the sole-plate being deranged and one of the fish-plates slightly cracked, but the joint held, and it is claimed that had the rail not fractured the fish-plate would not have gone. Anyhow, Mr. W. J. Hadfield, the City Surveyor, is sufficiently impressed with the possibilities of the new system to have a considerable number of joints made on certain lengths of the city tramways, and one of the results is said to be a distinctly smoother running of the electric cars.

### Lord Aberconway and the Miners.

Lord Aberconway was in Sheffield on Monday, presiding at a meeting of the shareholders in the Sheepbridge Coal and Iron Company, and, as might have been expected, the miners came in for a castigation—though when his lordship applies the lash of criticism the victims of his censure are at first scarcely aware of any sting, because he is clever enough to inflict it with an air of courtesy and even graciousness. Lord Aberconway is a lawyer, of course, and as such is skilled in the choice of words. There were times, however, in the course of his speech, when, as an orator who had temporarily lost control of his metaphor once remarked, he "removed the gloves from his lips." The miners had demanded, with menace, a share in the mines and were now requiring the owners, who had become nothing more than trustees of the collieries, to refrain from closing down unprofitable pits. But to keep them open, declared his lordship, would be to deprive the main body of miners of the profit they demanded. The owners' answer, therefore, when the men asked them to work unprofitable districts, would be: "You joined in smashing the coal trade during the last three months; you allowed the safety men to be taken out; you did nothing to prevent the flooding of the pits; and now you will have to abide by the results." Then Lord Aberconway ran over a few of those results. Foreign markets had been temporarily lost, depôts in France, Italy and other foreign countries had been filled with American and German coal, and this country had to pay during the strike £5,000,000 for foreign coal for home consumption. Blast-furnaces, rolling mills, foundries, shipyards, engineering works had been badly hit, if not actually brought to a standstill, and it was probable that even to-day not more than 25 per cent. of their normal capacity was being worked, whilst hundreds of thousands of men were still walking the streets because the strike had smashed the trade by which they earned their living. To this sweeping indictment of trade union policy his lordship added one or two facts relating to the Sheepbridge property. During the year the output had fallen by over 700,000 tons, and the wages lost to the men amounted to about £700,000, sufficient money to have secured for them a controlling interest in the Sheepbridge Company. A coal-getter's wages were now 23s. for work for which in 1913 he received 12s., yet the output per man for all men employed at the pits was now 158 tons as against 372 tons in 1913. "Could any figures," asked Lord Aberconway, "be more significant than those?"

## NORTH OF ENGLAND.

*(From our own Correspondent.)*

### The Trade Situation.

THERE have been no new developments of importance in the general trade situation in the North of England this week, and everything both as regards home and foreign trade remains as quiet and disappointing as could well be. No further progress can be reported in the direction of re-starting more works. In fact, some of the steel works plant which had been in operation has had to be laid idle again owing to the dearth of orders.

### Cleveland Iron Trade.

The Cleveland iron trade at the moment is absolutely colourless. The demand from all quarters is on a very limited scale, and there does not seem much prospect of more furnaces being put into operation. It is still cheaper to buy foreign pig iron than to produce it locally, and as a consequence our ironworkers look idly on whilst a constant flow of pig iron from the Continent to Cleveland is maintained. There are, however, a few hopeful signs. Continental producers, for example, aver that they have been selling at a loss and are inclined to advance their quotations. Moreover, a wage revision is due early next month which may further reduce the costs of production, and still more important from a producer's standpoint is the prospect next month of a reduction in the heavy railway charges. This is one of the big items in the ironmasters' bill of costs, and the railway companies have here an opportunity of materially assisting in a revival of industry. It is understood that their proposals for the new railway rates for coal and coke have already been lodged, but a reduction is wanted, not merely on coal and coke transport charges, but for all mineral transport, fuel, ore, and limestone. There remains the question of coal prices. In this direction ironmasters have sought in vain for concessions. Until coke comes down considerably, ironmasters are not likely to put more furnaces in operation. Meanwhile, production is on such a limited scale that makers are able to maintain the official scale of prices which has ruled so long, but any expansion of the output will, it is expected, be accompanied, or at least speedily followed, by a general reduction, and partly on this account, and partly owing to the stagnation of industry generally, buyers are only purchasing very small quantities.

### Hematite Pig Iron.

There is very little change in the East Coast hematite pig iron trade. The demand is very small. The price is too high for the foreigner, and consumption at home is so restricted that makers have a difficulty in marketing their output, although mixed numbers are now available either for home or export at 130s. per ton, and No. 1 at 132s. 6d.

### Iron-making Materials.

Business in the foreign ore trade is practically at a standstill, but a few deliveries under old contracts are still being made. Sellers' ideas vary from 27s. 6d. to 29s. per ton c.i.f. for best Rubio ore of 50 per cent. quality.

### Manufactured Iron and Steel.

In the manufactured iron and steel trade manufacturers are having great difficulty in keeping their plant in operation owing to lack of work. It is reported, however, that there is a little more inquiry from abroad, although little actual business has been put through. This week black sheets have been reduced to £16 per ton, and galvanised corrugated sheets to £19 per ton.

### The Coal Trade.

The Northern coal trade situation is not materially altered, and as a rule there is not much prospect of the position being firmly stabilised until the industry can be placed on a reliable economic basis. As things are, the collieries are in nearly every instance losing money heavily What is hoped for is lessened standing charges, coupled with vastly increased output, which may allow the producers to lower the prices and enable them to re-capture some of the lost export trade. The inquiries from abroad are very slow, and from the present experiences of exporters there seems to be no doubt that continental buyers are deliberately holding off the market, pending the further downward movement of prices which is confidently expected. As yet, however, the collieries have apparently gone as low as they intend, and are adhering more or less firmly to their figures, with, however, only poor results. There is therefore not nearly sufficient foreign trade to make the colliery position even moderately comfortable, most of them being obliged to carry on from day to day, and even then being idle as much as at work. The home trade is equally disappointing, with consumers only purchasing the minimum quantity, which all goes to show that there is as yet no immediate hope of the stabilisation of the industry and prices. The quantity of fuel of all classes on hand is enormous. Steam coals are exceedingly quiet, but fairly steady at recent figures. The demand for gas and coking coals is rather attenuated, especially for the poorer brands. Bunkers are a drug on the market, while the cheaper qualities of other classes of unscreened are equally depressed. There is not much change in the coke market, though gas coke continues scarce and in good demand at firm prices.

### The Technical Institute.

The new technical institute which has been opened at Middlesbrough provides a long-felt want in the Teesside and Cleveland districts. It has long been recognised that the efficiency of the various technical societies as educational forces has been impaired by the absence of a suitable building as headquarters. The welfare of the district demanded that the rising engineers, shipbuilders, metallurgical chemists, &c., should be provided with ample and attractive facilities for becoming thoroughly conversant with their own and cognate branches of science and technology. It was to meet this need that the Cleveland Institution of Engineers, in conjunction with the North-East Coast Institution of Engineers and Shipbuilders, have established the Institute. Though primarily established for the scientific worker and the student, the interests of the artisan are not to be neglected, the governing body of the Institute having decided to inaugurate lectures for workmen during the winter months. They will be of a popular nature, designed especially for the artisan, with the object of enabling him to understand more thoroughly the work and processes which he carries out daily. The lecturers will be chosen, sometimes from among experts and well-known authorities on various branches of science, occasionally from among the management of various works, and also at times from among the more capable workmen themselves.

## SCOTLAND.

*(From our own Correspondent.)*

### Famine Conditions.

THE state of matters disclosed at an inquiry into the valuations at certain steel works reveals a situation akin to a famine in orders. Steel works which in normal times employ upwards of 2000 workers have less than half their usual staffs, while, in addition, the working hours are severely cut down. One or two have been compelled to close down indefinitely. In the case of one of them at least, no steel has been melted since last December. In no case did there appear to be any prospect of a resumption.

### An Encouraging Item.

The withdrawal by the Cunard, Anchor and Donaldson lines of the embargo against further work being carried out on ships under construction in Clyde shipyards, strikes a more cheerful note. Costs still decline a little, and it is hoped that other owners may be led to follow suit. It is reported that three yards on the Clyde are affected by this decision.

### Low Output.

The Fife Coal Company, having given notice of the closure of a colliery employing 500 men, the officials of the miners' association in the district are making an effort to obviate such procedure. It is stated that the managing director, on being approached, explained that the output was inadequate. The output per man averaged about 15 cwt. per man per day, compared with the pre-

war average of 35 cwt. It was not desired to close the pit, but at present the coal raised cost 28s. to 30s. per ton, while the selling price was £1. An output of 30 cwt. per man per day would enable the company to keep the pit open. Mr. W. Adamson will acquaint the men of the facts and will advise them to increase output.

**New Business.**

The reported success of a Kirkcaldy firm against strong German competition is pleasant reading, especially at present. The contract embraces a large order for machinery to the value of £70,000, on behalf of a Rangoon firm. Messrs. Douglas and Grant, engineers, Kirkcaldy, are named as the successful competitors.

**Pig Iron Dull.**

Business in pig iron moves very slowly. The foundries now in operation are capable of giving quick delivery, but a considerable proportion of the output has to be put into stock, which is rather a discouraging feature with the market falling. The loss of the export trade is a hard blow. A normal home demand would, of course, easily absorb the present restricted output, but there seems little of improvement meantime.

**Steel and Iron.**

Though inquiries are quite numerous, indicating the presence of fresh business, actual contracts are as scarce as ever. Prices are slowly declining and competitive standards coming closer, but until either this becomes an established fact or the exchange reacts against foreign makers, the opportunities for home makers are not likely to increase. Home prices for steel are still some £5 per ton higher than foreign quotations, and even though deliveries from abroad are now more prolonged, local makers do not appear to be able to book anything of any account. The absolute dearth of business at the steel works has already been mentioned, and it may be said that the bar iron works are almost in a similar position. The necessity for lower costs is apparent to all, and it seems inconceivable that the workers at large are evidently quite willing to wait until actual want forces them to accept an economic standard of pay, instead of putting their shoulders to the wheel and producing in such quantities as to ensure a good return for their work. The exploitation of the worker for political purposes is still more than a menace, and it is a regrettable feature that those so influenced remain in ignorance of the true position of affairs.

**Wages in Manufactured Iron Trade.**

In view of the average selling price of iron having dropped to £17 0s. 1.39d. per ton during July and August, the wages of the workmen fall to be reduced 25 per cent. on basis rates.

**Coal.**

No improvement is recorded in the Scotch coal trade. In spite of greatly reduced prices, orders are as scarce as ever, with very few exceptions, and collieries have a hard struggle to keep going. Some, in fact, have had to close down, while at the majority broken time prevails. Industrial demands are very weak, and though on occasion household orders account for a fair tonnage, these as a rule have little effect on outputs. The loss of foreign business largely accounts for the present position, as in former time, during industrial depression, surplus outputs were disposed of overseas. Shipments show an improvement, but the gain is entirely in coastwise traffic. Only some forty steamers—and mostly of small tonnage—are loading Scotch coal to-day. Round coal is still almost neglected, while smalls, which constitute the bulk of the turnover, are becoming scarce in consequence. Aggregate shipments for the week were 191,087 tons, against 163,098 tons in the preceding week and 358,522 tons in the same week in 1913.

## WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

**Surprise for Coal Owners.**

THE conditions in the coal trade do not proceed at all on smooth lines. Apart from the fact that the demand for coal is negligible and the question of keeping collieries working is a day-to-day difficulty, coalowners have this week received a very severe shock by reason of being informed that they are liable for the whole of the month of September for the payment in wages of an amount equal to 97.57 per cent. on the standard rates of 1915 instead of 46.34 per cent. Under the agreement of July last, the wages payable during this month were to be based on the ascertained results of July, except that the actual wages of the miners should not be less than 3s. per day in the case of adults and 1s. 6d. per day in the case of persons under sixteen, below the wages paid last March, provided the balance of the ten million subsidy was sufficient for the purpose. As is now well known, although the calls on the subsidy were heavy in the coal-exporting districts, there is an unexhausted balance of approximately £4,000,000, so that the subsidy was more than sufficient to prevent a reduction in South Wales by more than 3s. per day below the March wages. The joint auditors' report on the working of the collieries in July, however, showed that the costs of production were so different to what was expected that the proportion of the wages bill to fall on the owners was increased from 29.5 per cent. on the 1915 standard rates to 46.34 per cent. on those rates. This increase was generally accepted as being in accordance with the agreement, but now, however, the Mines Department has stepped in and raised the point as to whether that increase from 29.5 to 46.34 per cent. was correct. The clause in question is Clause 11 (*g*), as follows:—"In any district in which the wages calculated in accordance with the terms of this settlement are less than the wages payable under the maximum reductions aforesaid (*i.e.*, 2s. for July, 3s. for August and 3s. 6d. for September), the difference shall be met by the owners in that district during September to the extent of the aggregate net profits realised by them on the district ascertainments for July, and during October to the extent of the aggregate net profits realised by them on the district ascertainments for July and August." The position is that the accountants either overlooked the above provision or else placed a wrong interpretation upon it, the result being that the Mines Department has decided that the wages for which the owners are responsible for this month are 97.57 per cent. and not 46.23 per cent.

**Wages Not Affected.**

The decision laid down by the Mines Department does not affect the actual wages of the workmen, but they are very vitally interested, as already collieries are being stopped from working. Coalowners have all along been selling their coal, if not at an actual loss, at any rate at such a figure as to be almost unremunerative, and had they known in the early part of this month what they do now they would not have kept their pits going. The amount involved is understood to be round about £600,000, but it is certain that most of the collieries cannot at present find their share of this amount. According to the secretary of the South Wales Coalowners' Association, he does not personally accept as accurate the increased percentage. He says that the liability of the owners to the payment of such wages as come within the scope of the clause under which the owners voluntarily agreed to forego any share in surplus profits during the temporary period, is not disputed; but the hope is not entirely abandoned that eventually the liability of the owners will be fixed at a lower figure than 97.57 per cent. on the 1915 standard rates.

**Effect on Market.**

The news regarding the extra burden to be placed on coalowners caused quite a sensation in coal trade circles, and thoroughly disorganised what little business was being negotiated. Many collieries at once withdrew their quotations, as it was estimated that the extra percentage, *i.e.*, 51 per cent., means an increase in the cost to the owners of at least 2s. 6d. to 5s. per ton on all the coal produced during the current month. During the past week, numerous collieries have been stopping work purely on account of the depression in trade, but this bombshell has rendered the position of the whole coalfield critical. Well-known colliery managers have expressed their view that it will be absolutely impossible to live under the new conditions. According to Mr. J. R. Llewellyn, who is one of the leading coalowners in this district, the new development in the financial situation will be that the steam coal collieries, almost without exception, will lose anything from 8s. to 10s. per ton this month. Prior to receiving the news regarding the Mines Department's decision, colliery salesmen had discounted the market in their efforts to capture foreign business and get orders to keep their collieries going, and were selling at anything from 2s. 6d. to 5s. per ton below the actual cost. Mr. Llewellyn says the coalowners have a genuine grievance in not being advised earlier, as they could then have protected themselves. So far as the Mines Department is concerned, it is stated that its view is that any mistake that has occurred is the result of a circular sent out by the South Wales Coalowners' Association. In their first calculation, the owners were keeping their profits, and when this was pointed out, they admitted that their accountants had made a mistake. The miners' leaders are very much perturbed at the new development, as they fear the consequences of extended unemployment. The general secretary and another leading member of the South Wales Council have already interviewed the Secretary of Mines respecting the continuing of the Government subsidy, and Mr. Bridgeman has promised to consider the matter.

**Railway and Dock Charges.**

Reference has recently been made to the high costs of transport and handling of South Wales coals, which are handicapping this district in its export operations. South Wales coalowners, shipowners, coal exporters, &c., are combining to bring pressure to bear to secure redress, and local railway companies have been asked to grant an interview to discuss the position. It is essential that all costs should be reduced if South Wales is to compete for orders. The secretary of the South Wales Coalowners, in a statement on the position, points out that although the total quantity of coal exported from the United Kingdom as cargo last month was 1,256,000 tons more than in August, 1920, the increase in South Wales was only 250,000 tons, which shows that South Wales is not recovering as fast as other districts. The increases in the railway rates and dock charges in South Wales have been proportionately greater than those in any other coalfield. They range from 100 per cent. to more than 400 per cent. above pre-war charges. In the case of tipping, weighing and wharfage in 1914, these amounted to 3¾d. per ton, whereas they are now 1s. 8d. per ton, an increase of 433 per cent. The increase in the railway rates is on an average 140 per cent., while the cost of bunkering tramp steamers at the Bristol Channel ports is not only between 400 and 500 per cent. higher than in 1913, but is even to-day three times as great as the cost at the Tyne ports.

**Trade Union Differences.**

Differences between members of trade unions were responsible last week-end for a strike of about 200 workmen at the Cardiff docks, which resulted in the discharging of the cargoes of three vessels being held up. The strikers were members of the Dockers' Union, who took exception to the Cardiff Railway Company officials in instructing some of their regular workmen, who are members of the National Union of Railwaymen, to do certain work at the warehouses. However, a representative of the Railway Company met Mr. Robert Williams, of the Transport Workers' Federation, and Mr. J. Holmes of the National Union of Railwaymen, on Monday last, and the outcome was that a temporary agreement was come to, and the men restarted work on Tuesday. Negotiations are being continued to arrange a permanent settlement of the differences.

**Coal Market.**

Business on the coal market has been extremely quiet, and numerous collieries have been obliged to work short time owing to the scarcity of orders, while the uncertain situation created by the development as to the amount to be borne by the owners concerning the miners' wage rate has completely upset ideas. Many colliery salesmen are now quoting 2s. 6d. to 5s. above the prices previously indicated, but as there was very little buying even at those figures, it will be realised that even inquiries which were in circulation are now held up. Most buyers have been looking for a further decline in prices instead of an increase, with the result that all calculations have been upset. One inquiry which colliery companies and exporters have recently received is from the French Marine Department. They have been asked to quote f.o.b. for 50,000 tons of specified Admiralty large, and to give c.i.f. prices for about 150,000 tons of smalls suitable for the making of fuel. The period of delivery is over the next three months and for shipment to various ports from the French Atlantic and Bay ports to the Mediterranean.

# Latest News from the Provinces.

## THE MIDLANDS AND STAFFORDSHIRE.

**Reduction in Corrugated Sheet Prices.**

LANCASHIRE sheet makers, it became known in Birmingham on Tuesday, have reduced the price of black and galvanised corrugated sheets by 20s. per ton, making the price for black £16 and galvanised £19. The sheet rolling mills of South Staffordshire and the Midlands in general, which are at present in operation, have been kept fairly busy, but there is a good deal of idle plant. It is hoped here that Midland manufacturers will fall into line with Lancashire and reduce their prices, and that this will so stimulate demand as to justify the re-starting of more mills in this district. Buyers are holding off, awaiting the announcement of a fall in price of Midland makes of sheets.

## SHEFFIELD.

**Iron, Steel, and Coal.**

Hard basic billets are now quoted about £11, and soft from £8 10s. to £10, though business has been done in the latter as low as £8, or even at a trifle less than that if delivery is fairly well forward. This only leaves a difference of about 30s. between the British and inferior continental steel. Derbyshire foundry pig iron one hears quoted at £7 at furnaces, but apparently it can be bought for a few shillings less than that. A few more furnaces must be going into blast, for the demand for coke is reported as strengthening. For that reason and because exports of large and small fuels show an improvement, the surplus in slacks is disappearing. Industrial fuels generally are in better request, which proves that works are becoming rather busier—as, of course, many of them are. Tungsten powder continues under a very poor demand, and the price has fallen to 1s. 9d. per pound, which nearly approaches the low record established in the days when severe competition between a solitary new British firm of makers and the whole group of German makers temporarily cut prices to rags.

## WALES AND ADJOINING COUNTIES.

**Coalowners' Decision.**

Coalowners' representatives on the South Wales Conciliation Board, after fully discussing the position respecting their liability to pay 97.57 per cent. instead of 46.34 per cent. on 1915 standard rates for this month, decided to send a deputation to wait on the Coal Mines Department in London on Wednesday evening.

**Steel Workers' Wages.**

The report of the joint auditors for the three months ending August 31st last concerning the South Wales and Monmouthshire iron and steel workers' sliding scale shows a reduction in the sliding scale of 108 per cent. The scale now stands at 172½ per cent. above the standard, so that as and from October 1st next it will stand at 64½ per cent. above the standard.

**Idle Collieries.**

Business is at a standstill on the coal market, and colliery stoppages are more numerous. Thousands of workmen are idle, and among the collieries affected there is D. Davis and Sons' Coedely Colliery, employing about 2000. The Executive Council of the South Wales Miners' Federation has selected its chairman and general secretary to accompany a deputation to the directors to discuss any suggestions put forward for the re-opening of the pits.

**Idle Miners.**

Owing to the temporary closing of collieries there are approximately 30,000 miners idle. Of this number 15,000 are out of work in the Rhondda Valley, 4000 in the Rhymney Valley, and about 7000 in the Aberdare district.

**Coal Agreement.**

Mr. A. J. Cook, miners' agent for the Rhondda district, has expressed the view that the present coal trade agreement will not last three months in South Wales.

# Current Prices for Metals and Fuels.

## IRON ORE.

| | |
|---|---|
| N.W. COAST— | |
| Native | — |
| [1] Spanish | 28/- |
| [1] N. African | 28/- |
| N.E. COAST— | |
| Native | — |
| Foreign (c.i.f.) | 28/- to 29/- |

## PIG IRON.

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| SCOTLAND—[1] | | |
| Hematite | 7 15 0 | — |
| No. 1 Foundry | 8 5 0 | — |
| No. 3 ,, | 8 0 0 | — |
| N.E. COAST— | | |
| Hematite Mixed Nos. | 6 10 0 | 6 10 0 |
| No. 1 | 6 12 6 | 6 12 6 |
| Cleveland— | | |
| No. 1 | — | — |
| Silicious Iron | — | — |
| No. 3 G.M.B. | 6 0 0 | 6 0 0 |
| No. 4 Foundry | 5 19 0 | 5 19 0 |
| No. 4 Forge | 5 17 6 | 5 17 6 |
| Mottled | 5 17 6 | 5 17 6 |
| White | 5 15 0 | 5 15 0 |
| MIDLANDS. | | |
| Staffs.— | | |
| All-mine (Cold Blast) | 17 0 0 to 17 7 6 | |
| Part Mine Forge | *None offering.* | |
| ,, Foundry No. 3 | *None offering.* | |
| Northampton *(Delivered Midlands).*— | | |
| Foundry Nos. 2 and 1 | *Nominal.* | |
| ,, No. 3 | 6 10 0 | |
| ,, Forge | *Nominal.* | |
| Derbyshire [2] *(All nominal).*— | | |
| No. 3 Foundry | 6 10 0 to 6 15 0 | |
| Forge | 6 0 0 | |
| Lincolnshire— | | |
| Basic | *Uncertain.* | |
| Foundry | ,, | |
| Forge | ,, | |
| N.W. COAST—[4] | | |
| N. Lancs. and Cum.— | | |
| Hematite Mixed Nos. | 7 15 0 | |

## MANUFACTURED IRON.

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| SCOTLAND— | | |
| Crown Bars | 14 0 0 | — |
| Best ,, | 17 0 0 | — |
| N.E. COAST— | | |
| Common Bars | 14 0 0 | — |
| Marked ,, | 18 0 0 | — |
| Tees | 14 10 0 | — |
| LANCS.— | | |
| Crown Bars | 14 0 0 | — |
| Hoops | 20 5 0 | 20 0 0 |
| S. YORKS.— | | |
| Crown Bars | 16 0 0 | — |
| Best ,, | 17 0 0 | — |
| Hoops | 17 5 0 | — |
| MIDLANDS— | | |
| Marked Bars (Staffs.) | 20 0 0 | — |
| Crown Bars | 16 0 0 | — |
| Nut and Bolt Bars | 15 10 0 to 16 0 0 | |
| Black Sheets (dbls. nom.) | 17 0 0 to 17 10 0 | |
| Galv. Sheets, 24 W.G. (f.o.b. L'pool, or equal) | 20 0 0 to 22 0 0 | |
| Gas Tube Strip | 17 10 0 | |

## STEEL.

| | Home.[6] £ s. d. | Export.[7] £ s. d. |
|---|---|---|
| SCOTLAND—[5] | | |
| Boiler Plates | 19 0 0 | — |
| Ship Plates ⅜in. and up | 14 0 0 | — |
| Sections | 13 10 0 | — |
| Steel Sheets ⅛in. to ⅜in. | 15 5 0 | — |
| Sheets (Gal. Cor. 24 B.G.) | — | 24 0 0 |

## STEEL (*continued*)

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| N.E. COAST— | | |
| Ship Plates | 14 0 0 | 14 0 0 |
| Angles | 13 10 0 | 13 10 0 |
| Boiler Plates | 19 0 0 | 19 0 0 |
| Joists | 13 10 0 | 13 10 0 |
| Heavy Rails | 14 0 0 | — |
| Fish-plates | 19 0 0 | — |
| Channels | 14 10 0 | — |
| Hard Billets | 11 0 0 | — |
| Soft Billets | 9 10 0 | — |
| N.W. COAST— | | |
| BARROW— | | |
| Heavy Rails | 14 0 0 | — |
| Light ,, | 16 0 0 to 18 0 0 | |
| Billets | 13 0 0 | — |
| Ship Plates | 14 0 0 | — |
| Boiler ,, | 20 0 0 | — |
| MANCHESTER *(Prices irregular and uncertain, unchanged)*— | | |
| [8] Bars (Round) | 12 0 0 to 14 0 0 | |
| [8] ,, (others) | 13 0 0 to 15 0 0 | |
| Hoops (Best) | 17 5 0 | 17 0 0 |
| ,, (Soft Steel) | 14 5 0 | 14 0 0 |
| Plates | 14 0 0 | — |
| ,, (Lancs. Boiler) | 20 0 0 | — |
| SHEFFIELD— | | |
| Siemens Acid Billets | 16 0 0 | — |
| Bessemer Billets | 15 10 0 | — |
| Hard Basic | 11 0 0 | — |
| Soft ,, | 8 10 0 to 10 0 0 | |
| Hoops | 14 5 0 | — |
| Soft Wire Rods | 13 15 0 | — |
| MIDLANDS— | | |
| Small Rolled Bars | 11 10 0 to 13 0 0 | |
| Bessemer Billets and Sheet Bars | 7 10 0 to 8 10 0 | |
| [2] Hoops | 14 0 0 | — |
| Tube Strip | 12 0 0 to 13 0 0 | |
| Angles and Joists | 13 10 0 | — |
| Tees | 14 10 0 | — |
| Bridge and Tank Plates | 14 0 0 | — |

## NON-FERROUS METALS.

| | |
|---|---|
| SWANSEA— | |
| Tin-plates, I.C., 20 by 14 | 20/6 to 22/- |
| Block Tin (cash) | 157 2 6 |
| ,, (three months) | 159 5 0 |
| Copper (cash) | 68 0 0 |
| ,, (three months) | 68 15 0 |
| Spanish Lead (cash) | 23 2 6 |
| ,, (three months) | 22 17 6 |
| Spelter (cash) | 26 0 0 |
| ,, (three months) | 26 10 0 |
| MANCHESTER— | |
| [9] Copper, Best Selected Ingots | 70 10 0 |
| ,, Electrolytic | 73 10 0 |
| [10] ,, Strong Sheets | 103 0 0 |
| ,, Loco Tubes | 0 1 2½ |
| Brass Loco Tubes | 0 1 0½ |
| ,, Condenser | 0 1 4½ |
| Lead, English | 24 5 0 |
| ,, Foreign | 23 5 0 |

(*Metal prices practically unchanged*).

## FERRO ALLOYS,

(*All prices new nominal*).

| | Per Ton. | Per Unit |
|---|---|---|
| Tungsten Metal Powder | 1/9 per lb. | |
| Ferro Tungsten | 1/6 to 1/8 per lb. | |
| Ferro Chrome, 4 p.c. to 6 p.c. carbon | £36 | 12/- |
| ,, 6 p.c. to 8 p.c. ,, | £34 | 12/- |
| ,, 8 p.c. to 10 p.c. ,, | £34 | 12/- |
| ,, Specially Refined | | |
| Max. 2 p.c. carbon | £79 | 28/- |
| ,, 1 p.c. ,, | £94 | 32/- |
| ,, 0·75 p.c. carbon | £110 | 41/- |
| ,, carbon free | 2/8 per lb. | |
| Metallic Chromium | 5/6 per lb. | |
| Ferro Manganese (per ton) | £18 for home. | |
| ,, Silicon, 45 p.c. to 50 p.c. | £13 0 0 scale 5/- per unit | |
| ,, ,, 75 p.c. | £20 0 0 scale 6/- per unit | |
| ,, Vanadium | 22/- per lb. | |
| ,, Molybdenum | 9/- per lb. | |
| ,, Titanium (carbon free) | 1/6 per lb. | |
| Nickel (per ton) | £190 | |
| Cobalt | 14/6 per lb. | |
| Aluminium (per ton) | £110 to £120 (British Official). | |

## FUELS.

### SCOTLAND.

| | Export. |
|---|---|
| LANARKSHIRE— | |
| (f.o.b. Glasgow)—Steam | [4] 24/6 |
| ,, ,, Ell | 26/6 to 27/- |
| ,, ,, Splint | 26/6 to 30/- |
| ,, ,, Trebles | 30/- |
| ,, ,, Doubles | 27/6 |
| ,, ,, Singles | 25/- |
| AYRSHIRE— | |
| (f.o.b. Ports)—Steam | 24/6 |
| ,, ,, Splint | 26/6 |
| ,, ,, Trebles | 29/- |
| FIFESHIRE— | |
| (f.o.b. Methil or Burntisland)—Steam | 21/- to 25/- |
| Screened Navigation | 32/- |
| Trebles | 29/- |
| Doubles | 26/- |
| Singles | 24/- |
| LOTHIANS— | |
| (f.o.b. Leith)—Best Steam | 22/- |
| Secondary Steam | 21/- |
| Trebles | 30/- |
| Doubles | 27/- |
| Singles | 25/- |

### ENGLAND.

| | |
|---|---|
| [11] N.W. COAST— | |
| Steams | 44/- |
| Household | 56/6 to 60/- |
| Coke | 37/6 to 42/6 |
| NORTHUMBERLAND— | |
| Best Steams | 27/6 to 30/- |
| Second Steams | 25/- to 27/- |
| Steam Smalls | 15/- to 17/6 |
| Unscreened | 22/6 to 27/- |
| Household | 30/- to 35/- |
| DURHAM— | |
| Best Gas | 29/- |
| Second | 25/- to 27/6 |
| Household | 30/- to 35/- |
| Foundry Coke | 45/- to 55/- |
| SHEFFIELD—[12] | |
| S. Yorks. Best Steam Hards | 33/2 to 33/8 |
| Derbyshire Hards | 32/8 to 33/2 |
| Seconds | 31/8 to 32/2 |
| Cobbles | 31/8 to 32/2 |
| Nuts | 31/2 to 32/2 |
| Washed Smalls | 28/8 to 30/2 |
| Best Hard Slacks | 20/- to 25/- |
| Seconds ,, | 20/- to 23/- |
| Soft Nutty ,, | 20/- to 25/- |
| Pea ,, | 18/- to 22/- |
| Small ,, | 15/- to 18/- |
| House, Branch | 37/2 to 37/8 |
| ,, Best Silkstone | 33/8 to 34/2 |
| Blast Furnace Coke | 25/- to 30/- |

### SOUTH WALES.[13]

| | |
|---|---|
| CARDIFF— | |
| Steam Coals: | |
| Best Smokeless Large | 30/- to 35/- |
| Second ,, ,, | 30/- to 32/6 |
| Best Dry Large | 30/- to 31/6 |
| Ordinary Dry Large | 27/6 to 30/- |
| Best Black Vein Large | 28/6 to 30/- |
| Western Valley ,, | 28/- to 30/- |
| Best Eastern Valley Large | 27/6 to 29/6 |
| Ordinary ,, ,, | 25/- to 27/6 |
| Best Steam Smalls | 20/- to 23/- |
| Ordinary ,, | 9/- to 12/6 |
| Washed Nuts | 30/- to 32/6 |
| No. 3 Rhondda Large | 32/6 to 37/6 |
| ,, ,, Smalls | 20/- to 25/- |
| No. 2 ,, Large | 24/- to 26/- |
| ,, ,, Through | 20/- to 22/6 |
| ,, ,, Smalls | 15/- to 16/- |
| Coke (export) | 55/- to 60/- |
| Patent Fuel | 30/- to 32/6 |
| Pitwood (ex ship) | 35/- to 37/6 |
| SWANSEA— | |
| Anthracite Coals: | |
| Best Large | 55/- to 57/6 |
| Seconds | 52/6 to 55/- |
| Red Vein | 42/6 to 47/6 |
| Big Vein | 55/- to 57/6 |
| Machine-made Cobbles | 70/- to 72/6 |
| Nuts | 70/- to 72/6 |
| Beans | 57/6 to 60/- |
| Peas | 40/- to 42/6 |
| Breaker Duff | 9/6 to 10/6 |
| Rubbly Culm | 16/6 to 17/6 |
| Steam Coals: | |
| Large | 32/6 to 35/- |
| Seconds | 30/- to 32/6 |
| Smalls | 15/- to 17/6 |
| Cargo Through | 22/6 to 25/- |

[1] Delivered. [2] Net Makers' works. [3] At furnaces. [4] Delivered Sheffield. [5] Glasgow, Lanarkshire and Ayrshire. [6] Home Prices—All delivered Glasgow Station.
[7] Export Prices—F.O.B. Glasgow. [8] Prices represent the real market before the *official* change was made. [9] These prices are practically alike now.
[10] Sheets reduced while other prices are advancing. [11] Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export.
[12] For inland sales. [13] Per ton f.o.b.

## French Engineering Notes.

*(From our Correspondent in Paris.)*

**The Exchange Rate.**

THE continued depreciation of the franc has had a further depressing effect upon foreign trade, and contributes to a weakening confidence in the state of affairs at home, for it is evident that if the national finances were sound the international value of the franc would be much higher, and there would be considerably more money available at home for business enterprise. As the precarious nature of the State finances is attributed to the failure of Germany to pay the indemnity under the original terms of the Treaty, it follows that there can be no hope of a steady recovery until France is able to straighten out her financial difficulties. Since she gave up relying entirely upon the indemnity, France has done much to consolidate her financial position, and there is no doubt that this improvement will continue until such time as the national credit has been restored sufficiently to eliminate the exchange fluctuations. The trouble at present is not so much the low value of the franc as its erratic movements. If the exchange rate were stable, as it continued to be for a considerable time, there would be no real impediment to foreign trade, since the values of commodities in different countries are practically the same, and are only expressed in terms of greater monetary values where the currency is depreciated. When turning French prices into English, it will be found that prime costs are very little below those in England, while even commodities are not much cheaper, the only difference being that the relatively high values in francs have a tendency to replace high-grade goods with articles of an inferior quality. When comparing goods of the same high-grade quality, the French and British prices are nearly the same. So ineffective is the adverse exchange rate in shutting out foreign goods that the import duties have had to be considerably increased in order to protect home industries. The only result of the depreciated currency is to reduce the country's purchasing power, and if the exchange rate were stable it would still be possible to do a fair foreign business, but with the fluctuations it is difficult for any foreign firm to secure a contract in France when the buyer may find himself obliged to pay more in francs than the stipulated price in pounds sterling. The exchange rate has, moreover, a moral effect, which is highly detrimental to business with Britain. Every Frenchman considers that his country has been frustrated of the indemnity, and apart from the mistaken impression that the exchange rate is sufficient of itself to shut out British goods, there is a strong disinclination to buy anything abroad.

**Foreign Trade.**

A year ago the steadily diminishing imports and the increasing exports were regarded as having ensured a "balance of trade" that would help materially to stabilise the exchange rate. For the first time the value of exports began to exceed the imports, and this was regarded as evidence of an improving home trade. Then it was observed that the arbitrary values imposed by the Customs Commission were misleading, on account of the variable value of the franc, and since the arbitrary values were adjusted there has been a considerable decline in the returns of foreign trade, which have, moreover, corresponded with the depression of the home industry and the putting into operation of the new protectionist fiscal policy. During the first eight months of the present year, the estimated value of imports was 13,607 million francs, representing a decline of no less than 20,734 million francs, as compared with the similar period of 1920. More than one-half of this declension was due to raw material, partly attributable no doubt to the British coal strike. The estimated value of exports at the same time fell from 17,234 million francs to 14,086 million francs, nearly the whole of the declension being due to the smaller value of exports of manufactured goods. In estimating the returns by weight, it is found that the imports fell to 20,814,182 tons, a contraction of nearly 11,000,000 tons. The imports of raw material dropped by 8,204,455 tons. The exports, on the other hand, increased from 7,858,831 tons to 9,555,403 tons, this improvement being due almost entirely to raw material. Thus, the heavy reduction in the imports of raw material and the increased exports at considerably lower prices prove that the home industry has been consuming much less, and the 50 per cent. reduction in the weight of goods imported shows that the new fiscal policy has become effective in restricting foreign trade without in any way benefiting the country.

**The Textile Strike.**

The strike that was at first restricted to the textile operatives in the Roubaix and Tourcoing districts and then extended in sympathy to the engineering and other industries, is still unsettled, although there is plenty of evidence that the men are willing to return to work as soon as they can free themselves from the control of the communistic agitators. The leaders interviewed the Prime Minister last week in the hope of submitting the dispute to arbitration, but the employers refuse to make any concession, arguing that they have delayed imposing a reduction in wages until they now find themselves confronted with the alternative of bringing down manufacturing costs or closing the factories. Under present conditions they are unable to meet foreign competition. The general strike which was to have suspended industrial activity throughout the district has failed, and several factories have re-started operations with men who have consented to resume work at the lower wage. This crucial struggle is likely to have the effect of breaking down the opposition to wages reduction that has been manifesting itself throughout the country. Even the miners have done nothing yet to carry out their threatened strike.

**Metallurgical Production.**

Since the restoration to France of Alsace-Lorraine, the metallurgical production of the country has increased enormously. During the first six months of the year, the production of iron ore was 7,532,868 tons, an increase of 1,693,464 tons as compared with the first half of 1913. The quantity of pig iron produced was 1,744,644 tons, an augmentation of 472,000 tons on the first six months of 1920. Steel in ingots and castings totalled 1,527,950 tons, an increase on the same period of 348,000 tons.

## TRANSMISSION OF ELECTRIC POWER FROM NORWAY TO DENMARK.

As a result of the investigations of the Scandinavian Commission which is discussing the question of the transmission of electric power from Norway to Denmark, the possibility of the scheme being realised in the near future is now considered to be much greater than it was before. One of the great stumbling blocks to the scheme hitherto appears to have been that the Danes were unable to consume a sufficient quantity of energy to make the transmission line pay. It is understood that they have now found that they could dispose of a larger supply, and it is estimated that Norway will possess a considerable surplus of power ready for delivery by the time the transmission line can be built. Some experts consider it probable that Norway will deliver power either from power stations on the river Glommen or from Nore, and that she will herself undertake the transmission of this power as far as the Swedish border, from which point the further transmission would be undertaken by Sweden. An official of the Norwegian Department of Water Courses considers that it would take at least three years to construct the necessary transmission line, and thinks that the delivery of power to Denmark could not be begun at any rate before the end of 1924 or the beginning of 1925, even if a plan should be agreed upon practically at once. Agreement on this point is not, however, likely in the near future, by reason of financial and technical difficulties. It is, for instance, proposed to employ a tension of 200,000 volts, which is thought to exceed the capacity of any cable which has hitherto been manufactured.

## THE LUBRICATION OF RAILWAY AXLE BOXES.

AMONG various experiments with oil, a system of splash lubrication for railway axle-boxes is described in the *Railway Review*. Near the bottom of the box, and hinged at the back end, is placed a plate or flat bar, its hinge permitting movement in a vertical arc and its outer end —near the front of the box—being seated on a coiled spring. Holes in this bar are fitted with hollow cones, the ¼in. apex openings of which are just above the top of the bar. A small roller or wheel having its axis parallel with that of the carriage axle is mounted in bearings on the bar and runs in an opening cut in the bar. To the end of the axle an excentric disc or cam is attached by a tap bolt, the throw of the excentric being ⅛in. or ¼in. This excentric rides in contact with the wheel on the spring bar, so that at each revolution the end of the bar is depressed, and the oil which fills the lower part of the box is thus squirted up through the cones to strike the journal. To provide for lateral movement of the axle within the axle-box, the bar roller has a travel of about 1¾in. along its shaft.

Another mechanical lubricating system employs loose waste to distribute oil which is pumped to it from a reservoir at the bottom of the axle-box. No change in box, brasses or journals is required. In this design the pumping is effected by the lateral movement of the journal and axle, a stud bearing against the end of the axle transmitting this movement to the short upper arm of a vertical lever. The lower end of this lever gives a corresponding but longer movement to a plunger in the oil reservoir, thus forcing oil up into the packing. An advantage of this arrangement is that in case of the mechanism becoming inoperative, the oily waste would still continue to lubricate the journal. In the tests it was found that this lubrication was sufficient for about 150 miles, after which the journal began to heat.

## ACTIVITY IN GERMANY.

IN a paper read by Mr. H. J. Davey and Mr. H. Gutteridge at the Olympia Exhibition on the 19th inst., a few notes are given on the position of the steel industry and allied trades, as observed by Mr. Davey during the past ten months of continuous work in Germany. Activity has been phenomenal. Rail, plate and sheet mills are full of orders for many months ahead, Russia figuring largely in demands for rails for main line tracks. Many works in the Stinnes and Thyssen combinations are extending even again; privately owned works as well, the latter being particularly lavish in office accommodation and equipment, despite the largely increased cost of building and decorating over there. Any attempt to calculate the profits earned is likely to yield illusory figures, owing to the difficulty of relating the German mark value to the increased cost of living in that country. But it is clear that large reserves of marks have been built up at prices which have enabled contracts to be obtained for supplies to Great Britain and her dependencies as well as other countries in the face of the keenest English, French and Belgian competition; and the more serious aspect of affairs so far as our own industries are concerned lies in the fact that for many years to come those reserves will play their part in competition for the world's industrial markets, unless measures are taken by Germany's competitors to improve the exchange value of the mark or she herself is compelled to do so by the approach of the day of reckoning and readjustment, which is stated by financiers to be fast approaching.

INSTITUTION OF NAVAL ARCHITECTS.—The Council of the Institution has awarded two post-graduate Research Scholarships in Naval Architecture, of the value of £250 per annum each, given by the Royal Commissioners of the 1851 Exhibition, as follows:—Mr. H. W. Nicholls, of the Royal Naval College, Greenwich, who will carry out a research on the vibration of ships; Mr. W. R. Andrew, of Liverpool University, who will investigate the behaviour of ships at sea during a long-distance voyage, and report upon shipbuilding and conditions abroad.

## British Patent Specifications.

*When an invention is communicated from abroad the name and address of the communicator are printed in italics.*

*When an abridgment is not illustrated the Specification is without drawings.*

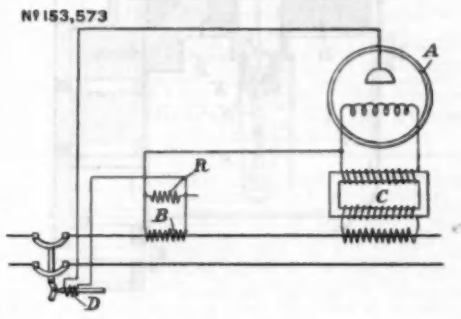
*Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.*

*The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.*

### SWITCHGEAR.

153,573. November 6th, 1919.—IMPROVEMENTS RELATING TO INTERRUPTING DEVICES FOR ELECTRIC CIRCUITS, Metropolitan-Vickers Electrical Company, Limited, of 4, Central Buildings, Westminster.

ACCORDING to this invention, the trip coil of a circuit breaker is connected in series with a vacuum electric valve A and the cathode of the valve is supplied with energy from the circuit in which the trip coil is used. The trip coil circuit is supplied with energy from a transformer B connected in series with the main circuit, and the hot cathode is preferably supplied with current

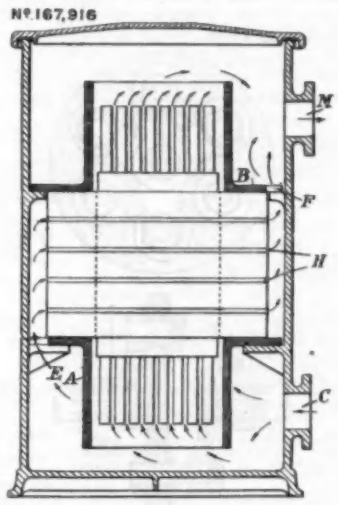



from a saturated transformer C, the primary winding of which is energised from the same circuit. When the current in the circuit rises above the predetermined limit the cathode of the valve is heated to a higher degree than it was previously heated, and sufficient current passes through the valve and coil D to trip the breaker. R is a resistance.—*August 25th, 1921.*

### TRANSFORMERS.

167,916. June 12th, 1920.—IMPROVEMENTS IN ELECTRICAL TRANSFORMERS, Guilio Schroeder, of Hillere Park-road, Hale, Cheshire.

The object of this invention is to improve the circulation of oil in transformers. The oil is forced through definite paths, as indicated by the arrows, and also around the outside transformer core and windings, and then through a separate cooler. Parti-

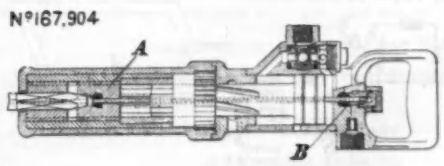



tions are formed by tubular flanges A and B carried on brackets. The oil entering at the inlet C, passes up inside the partition A and through the apertures E and F and through ducts H in the carcase. Both streams unite in the upper part of the case and leave by way of the outlet M.—*August 25th, 1921.*

### MINES AND METALS.

167,904. June 5th, 1920.—ROCK DRILLS, R. de Hele St. Stephens, Homefield, Camborne, Cornwall, and A. Ewing, 4, Broad Street-place, London, E.C. 2.

In order to prevent the admixture of air with the water fed through hollow drill steels, with the object of flushing out the hole being drilled, the water is led to the anvil block A by a

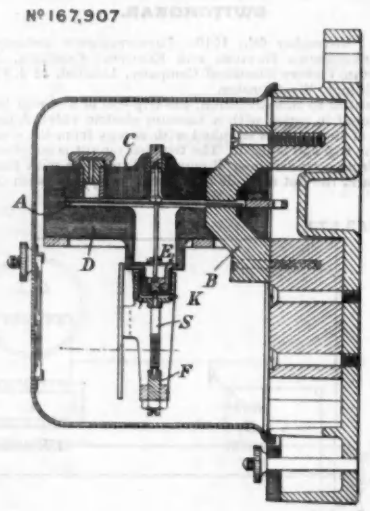



central pipe which passes through a hole in the working piston. The pipe is fixed into the anvil block and passes through a watertight gland B in the head of the drill, which permits the necessary rotary and longitudinal movement.—*August 25th, 1921.*

## TESTING AND MEASURING INSTRUMENTS.

167,907. March 7th, 1921.—IMPROVEMENTS IN AND RELATING TO ELECTRICITY METERS, PARTICULARLY OF THE MERCURY MOTOR TYPE, The British Thomson-Houston Company, of 83, Cannon-street, E.C. 4. and Arthur Primrose Young, of Dovedale, Priory-road, Kenilworth, Warwickshire.

This invention relates to electricity meters of the mercury motor type in which the rotor is totally submerged in mercury contained in a closed receptacle. The object of the invention is to reduce friction. The blocks of insulating material C and D form a chamber for mercury, within which the disc A rotates. The spindle of the disc is provided with an upper bearing secured to the block C and a lower bearing attached to the block D. The spindle carries a soft iron armature E. Below this spindle is a

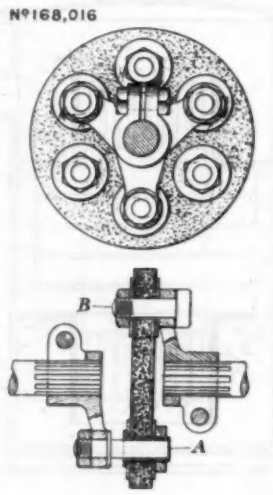



registering spindle S, the lower end of which is provided with a bearing F, whilst the upper bearing is fixed in the block D. A U-shaped permanent magnet K is secured to the spindle with its poles projecting upwards, so that as the armature A rotates the magnet and its shaft will also rotate. A worm is formed on the lower shaft and the rotation of the shaft is transmitted through this to the wheel connected to the registering train in a well-known manner. With a meter constructed on the above lines the disc E and armature A tend to float on the mercury, thereby taking the pressure off the lower bearing and diminishing the friction. Attraction between the permanent magnet K and armature E tends to raise the spindle.—*August 25th*, 1921.

## TRANSMISSION OF POWER.

168,016. May 19th, 1921.—UNIVERSAL JOINTS, J. Y. Sangster, 8, St. Agnes-road, Moseley, Birmingham.

In order to relieve the disc of this flexible coupling of stresses which might be caused by end movement of the shafts, one

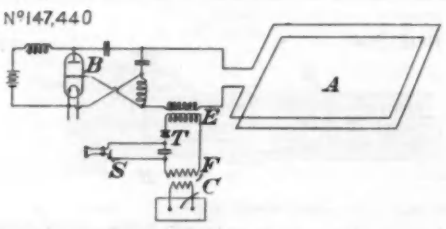



set of the driving studs is free to slide longitudinally through bushes fixed in the disc. One of the sliding studs is shown at A. The studs connected with the other piece of shaft are bolted to the disc—see B.—*August 25th*, 1921.

## MISCELLANEOUS.

147,440. July 7th, 1920.—AN ARRANGEMENT FOR LOCATING UNDERGROUND AND HIDDEN ELECTRICAL CONDUCTORS, Gesellschaft für Drahtlose Telegraphie M.b.H., of 9, Tempelhofer ufer, Berlin.

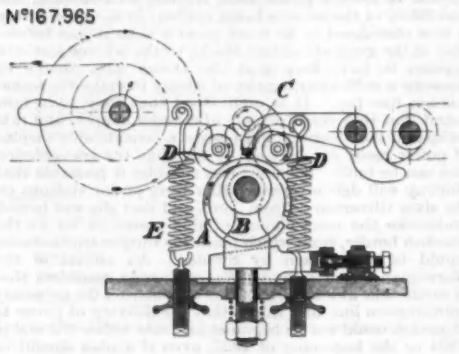
The apparatus described in this specification works upon the




principle that conducting objects in the vicinity of the coil A produce a frequency change in the oscillating circuit shown on the left. The valve generator B produces oscillations in the well-known manner, and these oscillations are conveyed to the coil A, which produces a large stray field. A local generator C produces oscillations of a period differing from that of the generator B, and the oscillations from the former are impressed on the coil A by means of the coupling transformers E and F. Frequency alterations, which are caused by metallic ores or the like and which act on the coil A, are detected by the detector T and telephone receiver S.—*August 25th*, 1921.

167,965. August 19th, 1920.—PISTON RINGS, R. Ferber, Sulzbach, Wurtemburg, and E. Junker, Lausanne.

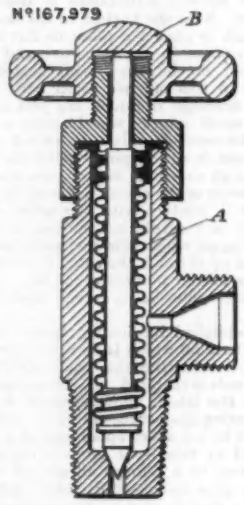
The chief interest in this invention lies in the method adopted to bring together the ends of a piston ring after it has been cut to form a stepped joint. The operation is effected by a combined hammering, rolling and bending action in a special machine.




The ring A is supported by a roller B and is acted on by the hammer C. At the same time the grooved rollers D D feed the ring round and bend it together on account of the tension of the spring E. It is claimed that the system is quicker and produces a more satisfactory result than other processes.—*August 25th*, 1921.

167,979. October 5th, 1920.—HIGH-PRESSURE VALVES, *A. A. Thornton*, 8, *Quality-court, Chancery-lane, London, W.C.* 2.

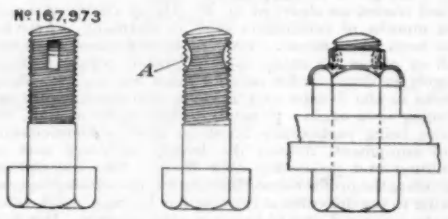
In this valve the usual gland packing for the stem is replaced by the helically corrugated diaphragm A. At the lower end the diaphragm is hermetically attached to the valve stem, while




the upper end is similarly screwed to the valve body. The valve stem is of such a diameter that it prevents the diaphragm being collapsed by external pressure and extends upwards to come into contact with the hand wheel B. The diaphragm A is of such proportions that it tends to open the valve when the hand wheel is slacked back.—*August 25th*, 1921.

167,973. September 2nd, 1920.—LOCK NUTS, W. Guest, 42, Mayhill-road, Charlton, London, S.E. 7.

For this lock nut two grooves A are made in the end of the bolt. A soft metal cap is slipped over the end of the bolt and




engages the flats of the nut. The sleeve is then indented into the grooves by any convenient means. As an alternative it is suggested that the sleeve may be made in one piece with the nut.—*August 25th*, 1921.

167,975. September 17th, 1920.—FLANGING METALS, *T. W. Rogers*, 33, *Chancery-lane, London*.

In the process of flanging plates, such, for instance, as boiler

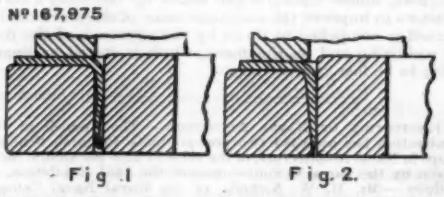
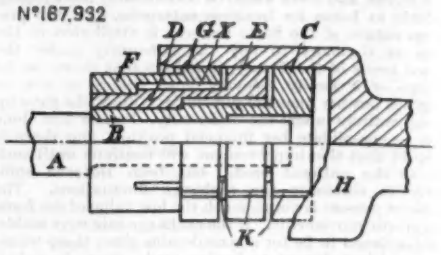



Fig. 1 Fig. 2.

ends, it is usual for the inturned flange to get a wavy surface on account of the operation reducing the thickness of the plate, which consequently does not completely fill the space between the dies of the press—see Fig. 1. For this reason the inventors make the dies as shown in Fig. 2. The space between the dies is tapered to the same extent as the taper produced in the plate, with the result that one of the faces of the flange is made truly cylindrical.—*August 25th*, 1921.

167,932. June 22nd, 1920.—IMPROVEMENTS IN ELECTRICAL CONTACTS OF THE PLUG AND SOCKET TYPE, Herbert Jasper Beard Thomas, of 1, Albert-terrace, Haverton Hill, Durham.

On the spindle A of the plug is mounted a cylinder B with a contact C, and outside this cylinder is a cylinder D with a contact E. Similarly, over the cylinder D is a cylinder F with a contact




G. All three contacts make connection with the interior surface of the socket. The cylinders are slit for a portion of their length as shown at K, and spaces are left between the cylinders as shown at X, so that each cylinder can be compressed or reduced in diameter irrespective of the others, and it is therefore possible for all three contact zones to make independent contact with the interior surface of the plug H.—*August 25th*, 1921.

## Forthcoming Engagements.

SATURDAY, OCTOBER 1ST.

INSTITUTION OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—College of Technology, Manchester. Presidential address by Mr. W. H. Meadowcroft. Discussion on "A General Survey of Affairs in the Foundry World and Our Institution in Particular." 4 p.m.

MONDAY, OCTOBER 3RD.

SOCIETY OF ENGINEERS.—Geological Society, Burlington House, W. 1. Paper, "The Winning of Tidal Lands in British Guiana," by Mr. Gerald O. Case. 5.30 p.m.

TUESDAY, OCTOBER 4TH.

BRADFORD ENGINEERING SOCIETY.—Hall of Technical College, Bradford. Lecture on "The Steam Turbine for Mill Driving," by Professor Gerald Stoney, D.Sc. 7.30 p.m.

WEDNESDAY, OCTOBER 5TH.

INSTITUTION OF AUTOMOBILE ENGINEERS: NORTH OF ENGLAND CENTRE.—Assembly Room, Education Offices, Salford, Manchester. Informal meeting. Discussion on labour-saving devices in connection with the use of pneumatic tires on motor cars. 7.30 p.m.

INSTITUTION OF RAILWAY SIGNAL ENGINEERS.—Midland Grand Hotel, St. Pancras. Resumed discussion on paper, "Problems of Automatic Train Control," by Mr. W. J. Thorrowgood. 6 p.m.

THORNYCROFT ENGINEERING SOCIETY.—J. I. Thornycroft and Co., Limited, Works Canteen, Basingstoke. "Heat Treatment of Steel," by Mr. D. Flather. 7 p.m.

WEDNESDAY AND THURSDAY, OCTOBER 5TH AND 6TH.

COMMERCIAL MOTOR USERS' ASSOCIATION.—Fourth Provincial Conference of the National Council at Bristol.

FRIDAY, OCTOBER 7TH.

THE INSTITUTION OF LOCOMOTIVE ENGINEERS (LONDON).—Visit to the works of the Broughton Copper Company, Manchester. Meet at the entrance of the works at 2.15 p.m., which are situated in Silk-street, Blackfriar-road, Manchester. After the visit the first general meeting will be held at the Victoria Hotel, at 5 p.m., when a paper on "Notes on Axle-boxes and Horn Blocks," by Mr. A. E. Kyffin, will be read and discussed.

THE JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, Westminster. "Colour Vision and Colour Blindness," by Dr. Edridge Green. 8 p.m.

SATURDAY, OCTOBER 8TH.

ASSOCIATION OF ENGINEERS-IN-CHARGE.—Holborn Restaurant, London. Twenty-first annual dinner. 6 p.m.

MONDAY, OCTOBER 10TH.

INSTITUTE OF TRANSPORT.—Victoria Hall, Hotel Cecil, London, W.C. 2. Second Institute Dinner. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: LOUGHBOROUGH GRADUATES.—Room 119, The College, Loughborough. "Tests on the Efficiency of a Six-cylinder Aero-engine," by Mr. W. P. Johnson. 7 p.m.

TUESDAY AND WEDNESDAY, OCTOBER 11TH AND 12TH.

INSTITUTION OF GAS ENGINEERS.—Central Hall, Westminster. Annual meeting.

WEDNESDAY, OCTOBER 12TH.

ROYAL SANITARY INSTITUTE.—90, Buckingham Palace-road. Discussion on "Plumbing and Sanitation on Board Ship." 4 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Royal Society of Arts, John-street, Adelphi, W.C. 2. Ordinary general meeting. Presidential address, "Industrial Standardisation," by Mr. Geo. W. Watson. 8 p.m.

CREOSOTE FOR TIMBER.—A British standard specification has been issued by the British Engineering Standards Association for creosote for the preservation of timber. It covers the requirements of creosote suitable for the treatment of railway sleepers and for telegraph, telephone and hangar poles and similar purposes. The clauses of the specification include a description of the substance and limits for specific gravity, fluidity, water content, distillation, tar acids and matter insoluble in benzol (benzene). The specification can be obtained from the Secretary of the British Engineering Standards Association, 28, Victoria-street, London, S.W. 1, price 1s. 2d. post free.